Grid-tied renewable energy solutions for the residential customers in Midrand, Gauteng, South Africa

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DECLARATION

I, Vhuhwavho Munyai, declare that this business venture proposal is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Vhuhwavho Munyai

Signed at Johannesburg on the 03 day of November 2021

Dedication

I dedicate this research to my wife and son, who have sacrificed immensely for me to complete my research study. Thank you so much for the support and love. Much appreciated.

Acknowledgement

I would like to thank my family, my wife and son, for supporting me through the research journey and the entire MBA Journey.

I'm grateful for the support and guidance I got from my supervisor, Dr Robert Venter, his feedback was insightful and impactful.

I would also like to express my gratitude to everyone who participated in the online survey that includes one of the Estate agencies that requested to remain anonymous and households in Midrand.

Glossary of terms and definition

Baseload power supply - Is the minimum level of power demand to the consumers throughout the day.

Commercial operation – Is when the construction and optimisation of the power station unit are complete and the operator, usually Generation division, takes over the plant and runs it on a regular basis.

Concentrated solar power - uses mirrors to concentrate the thermal energy of the sun and heat a transfer fluid. The heat energy is then used to produce steam, with which electricity is generated in conventional turbines.

Decentralised power – Is designated by generation and supply of electric power close to the load centres with a key aim of providing power for local energy requirements and use. A decentralised electric system can function connected to the grid where any additional energy is supplied to the grid for use or as an off-grid system where it is independent and supplying the local.

Degradation rate – rate at which the conversion of sunlight to electricity by solar panels is declining over time.

Electric Utility - Is a privately or publicly owned company that is responsible for Generation, Transmission, and Distribution of electricity to end users or customers. Electric utilities can either be involved in Generation or Transmission or distributions. A vertically integrated utility is responsible for everything Generation, Transmission and Distribution.

Electricity distribution – Is a system of electrical wires that transport electricity from the transmission substation at low voltage and over a short distance to the end users (homes and businesses).

Electricity reserve - Is the amount of reserve energy in a power system remaining after the all the customers supply needs and requirements have been met at all times.

Electricity transmission – Is a system of electrical wires that transport electricity from the source of generation at high voltage and over a long distance to the local substation.

Energy Availability Factor – Is the percentage of maximum energy generation that a plant is capable of supplying to the electrical grid, limited only by planned and unplanned outages.

Energy storage – Is the process of converting electrical energy into another form of energy and later accessed when it is needed.

Feed-in tariff – Is a price for electricity that is paid by national authorities for individual or businesses when they produce and sell energy generated by renewable energy sources and it is usually higher than regular prices.

Fossil fuels – Are energy resources that are used to produce electricity but are available in finite quantities, which include oil, coal and natural gas.

Global Horizontal Irradiation – Is the sum of direct and diffuse irradiation components received by a horizontal surface measured in kWh/m^2 .The horizontal solar radiation is the sum of direct and diffuse irradiation received by a horizontal surface and it is used to approximate the solar irradiation potential in an area.

Integrated Energy Plan – Is an over-arching, coordinated energy plan combing the constraints and capabilities or alternative energy carriers to meet the country's energy needs.

Integrated resource Plan - Is the coordinated schedule for generation expansion and demand-side intervention programme, taking into consideration multiple criteria to meet electricity demand.

Load shedding – Is the intentional cutting of power to consumers in a scheduled manner when the electricity system cannot meet demand in order to avoid total system failure or system blackout.

National Energy Regulator of South Africa - Is a regulatory authority established to regulate the electricity, piped-gas and petroleum pipeline industries.

Off-grid - Is the electrical system that is not connected to the main or national transmission grid in electricity.

Peaking power – Is the power provided for short periods at times of peak demand.

Practical solar PV potential – Is the power output achievable by a typical PV system.

Registered entity – Is the entity generating electricity that has been registered by the Energy Regulator.

Renewable energy – Is energy produced from natural resources that replenish themselves without depleting the plant resources, these resources include sunlight, wind, rain, tides, waves, biomass and thermal energy.

Reserve margin – Is (capacity minus demand)/demand, where capacity is the expected maximum available supply and demand is expected peak demand.

Residential energy consumption - Is all the energy consumed by households including heating, cooking, lighting and water heating.

Small-Scale Embedded Generator – Is a customer that operates a generation facility ≤ 1 MW and connected at low voltage to a public Distribution system, who is entitled to a licence exemption.

Acronyms and abbreviation

AC – Alternating current

BOS – Balance of system

DC – Direct current

GW – Gigawatt (1000MW)

GWh – Gigawatt-hour (1000MWh)

kW – Kilowatt (1000W)

kWh – Kilowatt hour

kWp – Kilowatt peak

LCOE – Levelised Cost of Energy

MW – Megawatt (1000kW)

PV - Photovoltaic

PVOUT – Photovoltaic electricity potential or expected output from a PV system

TW – Terawatt (1000GW)

TWh – Terawatt-hour (1000GWh)

W – Watt (unit of power)

WACC – Weighted Average Cost of capital

WBS – University of Witwatersrand Business School

Executive summary

South Africa is experiencing electricity shortage crisis that is causing loadshedding. The electricity shortage crisis has been going on for almost fourteen years without a successful solution. Loadshedding has become a common occurrence and it is moving from bad to worse. The electricity crisis is caused by various factors. The slow and delayed implementation of energy policy by the government. The overdue new build programme that has been running for nearly fifteen years that included the recommission of previously mothballed coal-fired power stations such as Camden, Grootvlei and Komati and building of new power stations Medupi, Kusile and Ingula, and the aging and poorly maintained Eskom power stations.

This business venture proposes a grid-tied residential renewable energy system (RRES) to address the electricity shortage crisis for residential customers in Midrand, Gauteng, South Africa. The grid-tied residential renewable energy system is an innovative renewable energy power system that will generate electricity for the residential customers and is fused with fourth industrial technologies to create great customer experience. Internet of things technology will be used to monitor and control all the appliances, entertainment systems, lighting and security system remotely in the homes of the customers. Artificial intelligence technology will be used to automate data analysis and visualisation for the customer generation and consumption data for their homes. RRES aims to disrupt the traditional way of supplying electricity and avoid loadshedding for residential customer.

The business venture research aims to quantify the demand for RRES to determine the business venture viability. It seeks to understand and identify determinants that motivate or hinder individuals from purchasing and installing the RRES. Given that there has been low adoption rate of renewable energy systems in South Africa. The outcome from the study will inform the development of business venture, on how to address the low adoption rate of renewable energy systems by residential customers and create a business venture that is aligned to the customer’s demand and needs. Furthermore, it targets to develop a business venture that would survive for long and launch efficiently to the market.

In order to determine the viability of the business opportunity and gain insights on key drivers and barriers that influence the purchasing and installing of RRES, a cross-sectional online survey was conducted involving 321 respondents from Midrand. The survey questions were based on the persuasion attributes of the Roger’s theory of innovation diffusion.

The survey showed that there is a huge demand in Midrand with 85% of participants interested in purchasing and installing RRES. Financial projections analysis also showed that the business venture is viable, as the company will be profitable and has a positive net present value (NPV).

The attributes and determinants highlight the key elements that influence the consumers to buy and install RRES and the adoption rate has a direct influence on the sales of RRES that determine the business venture viability.

The key attributes and determinants identified would be leveraged to increase adoption. There are three main attributes of RRES that were identified that will significantly determine adoption rate in Midrand. Relative advantage was the most important attribute in influencing consumer's attitude towards adoption decision, then followed by compatibility and complexity.

Energy security that is inexhaustive nature of renewable energy was the most important determinant for adoption then followed by financial viability that is cheap and affordable price and environmental friendliness that is reducing carbon dioxide emissions. Lack of knowledge about the technology is the key barrier to adoption.

The access to market, human and finances capital are the most factors that the new business venture must prioritised to ensure the success and growth. The business venture will focus on the building minimum viable product that would be launched to the market as soon as possible before investing more time, effort and financial resources.

To get access in the market, the business venture will satisfy the licensing and registration requirement as outlined by NERSA, personal information protection and management requirements and key accreditation. The issue of funding, the owner will be bootstrapping the first phase of the business to limit financial exposure risks. The human capital will ensure that highly skilled individual is utilised to build the business venture. To minimise wastage on time, effort and financial resources, the existing MVP coupled with fourth industrial revolution technologies will be launch to the market as soon as possible.

The RRES key attributes aligns well with the consumer's key attributes and determinants that influence them to buy and install RRES. There is an overwhelming evidence that the business venture has strong prospects of success in the energy market and should continue with the launch into the market.

Keywords: Grid-tied Residential Renewable Energy System, Renewable Energy Technologies, Loadshedding, Fourth Industrial Revolution, Diffusion of Innovation and Adoption.

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1 Introduction business venture proposal

Trace (2020) mentions that globally there are over 200 million households who use an unreliable grid connection. In Africa, less than 43% of Africans have a reliable supply of electricity. Many households are experiencing unplanned, unpredictable and extensive power outages. In South Africa, since 2007 the power system has become unreliable and households have been experiencing loadshedding (Joffe, 2012). Over the years, the situation has gotten worse. According to the Council for Scientific and Industrial Research (CSIR), South Africa had the worst year of loadshedding in 2019 and expects the loadshedding to remain for two to three years depending on the response of the government(Tshwane, 2020).

South Africa's electricity supply industry (ESI) is dominated by a vertically integrated and state-owned utility, Eskom, playing a key role in generation, transmission and distribution(*South Africa Power*, 2020). Majority of the households depends on Eskom for electricity and when Eskom fails to supply electricity majority of the households suffer. Eskom is experiencing serious financial and operational challenges and as a result is failing to provide reliable supply of electricity to households(Eskom, 2019). Loadshedding has put economic and social life under severe pressure and an urgent solution is required for the households.

At the heart of this business venture proposal is a grid-tied renewable energy solution for the households' electricity shortage crisis. The grid-tied renewable energy solution will be fused with the fourth industrial revolution technologies to offer great customer services. Internet of things that will enable the controlling and monitoring of household's appliance and systems. Artificial intelligence for tracking and monitoring of the consumer's electricity generation and consumption.

However, there has been a slow adoption of renewable energy solutions at the household level in South Africa. Several polices and plans to stimulate the adoption has been introduced with little success. In 1998, one of the key energy policy objectives was to secure supply through diversity that included renewable energy(Energy, 1998). While in 2003, the energy policy focused on the development of renewable energy in South Africa and aimed to reach 10 000 GWh renewable energy contribution by 2013(Winkler, 2005). In 2011, the IRP 2010 was published and had a renewable energy allocation(Africa & Energy, 2011). In 2019, the IRP 2010 was reviewed and 500MW was allocated to stimulate the growth of self-generation(DMRE, 2019). As of 2017, the estimated number of installed small scale renewable energy was about 138 350 installations, which translated to an estimated 144 MW installed, majority of the installations were commercial and industrial customers(Rycroft, 2017). The contribution from the residential customers were low and there is no information explaining the low adoption rate.

As result, the business venture proposal aims to quantify the demand for RRES and seeks to understand and identify the key drivers and barriers that influences the adoption rate of the renewable energy system given that there has been a low adoption rate of renewable energy systems by residential customers. The insights gained would be used to develop a business venture that would be able to address the low adoption rate and is aligned to customer's needs and demands. Furthermore, it aims to develop a business venture that would survive for long given the high failure rate for start-ups and launch efficiently to the market.

The business venture proposal will determine the demand for RRES in Midrand in order to establish the new venture viability. The five persuasion attributes of Roger's diffusion of innovation theory – relative advantage, compatibility, complexity, observability and trialability, will be used to identify the drivers and barriers on consumer's attitude in adopting renewable energy solutions in Midrand. The diffusion of innovation theory explains in what way, why, and what speed new innovations like RRESs are adopted. The entrepreneurial process model and lean start-up would be used to identify major factors to consider to ensure that the new venture survive for long and is efficiently launched to the market.

This chapter will be divided into four key sections that include scope of the business venture (section 1.1), research purpose statement (section 1.2), research questions (section 1.3), and limitations (section 1.4).

1.1 Scope of the business venture

The major problem to be addressed in this study is the electricity shortage crisis that is causing unpredictable and extensive time of loadshedding for households. Loadshedding is negatively affecting all sectors that include industrial, mining, agriculture and residential sector(Inglesi-Lotz & Blignaut, 2011). However, the business venture proposal will only focus on developing a solution for residential sector.

South Africa has one of the best renewable energy resources in the world(van Niekerk, 2012), which has not been fully explored especially in the residential sector. This is evidently showing that there is a good business opportunity to provide renewable energy system solution to the residential customers to resolve the electricity shortage crisis. This busine venture research proposes a grid-tied renewable energy solution fused with fourth industrial revolution technologies for residential customers.

However, it has been observed that there is a low adoption rate for renewable energy systems by the residential customers. To ensure a viable and successful business venture, a study on the key drivers and barriers that influence the consumer's attitude to adopt renewable energy systems in Midrand will be conducted.

To make certain that the new venture enters the new market effectively, the entrepreneurial ecosystem model will be used to identify pertinent factors to consider and incorporate into the business venture proposal. To address the high failure rate of new venture and simplify the launch of the RRES to the market, the lean start-up methodology will be scrutinised and adopted in the business venture proposal.

1.2 Research purpose statement

The purpose of the study is to develop a business venture proposal for a grid-tied renewable energy system solution fused with the fourth industrial revolution technologies, to resolve the electricity shortage crisis for the residential customers in Midrand.

The renewable energy market in South Africa is still at an early stage despite the efforts to stimulate it(Zeng et al., 2017). For the longest time, electricity in South Africa was cheap and reliable(Schmidt et al., 2017). Given the failure of Eskom to reliably deliver electricity, it now provides an opportunity for new business venture to launch their products to the market.

There are various challenges that new businesses experiences when launching new products to the market. Alrashoud and Tokimatsu (2019) outline that consumers tend to resist the green innovation, even when the benefits of the new product or service are greater than the existing ones. About 40 - 90% of innovations in various product groups fail to survive in the market, and the failure has been attributed primarily to consumer resistance. The diffusion of new technology in most cases is slow and difficult due to the resistance to new ways (Franceschinis et al., 2017). This business venture proposal seeks to understand the drivers and barriers of adoption, the insights gained will used to address the low adoption rate.

In South Africa, it has been observed that the adoption of renewable energy systems has been slow and difficult. To make certain that this business venture is viable, overcome the low adoption challenge, and it survives for long and efficiently launch to the market. The business venture proposal will investigate the following aspects:

- Determine what is the demand for renewable energy solutions at the household level in Midrand;
- Identify the diffusion of innovation key determinants and barriers on consumer's attitude towards adoption of RRES in Midrand;

- Develop the business venture strategy, how is the business going to be different from its competitors and maintain its competitive advantage;
- Select the appropriate business model that is aligned to the business venture stage;
- Decide how the business venture is going to source capital for product development, installation and operations;
- Create marketing strategy that will attract consumers and other key stakeholders;
- Evaluate the policy, legal and regulations in energy industry;
- Build the new venture using lean start-up methodology ;
- Apply the most efficient entrepreneurial process in launching the business.

1.3 Research questions

The research study has three key goals (i) to quantify the number of end users who will adopt the RRES in Midrand so as to establish the viability of the business venture , (ii) to identify the key determinants and barriers for consumer's attitude towards adoption of RRES in order to develop a business venture that address the low adoption of RRES and responds to customer's needs and demands, and (iii) to develop business venture that would survive for long and launch efficiently to the market. The research questions are developed to understand the residential market potential for the RRES ,the key determinants for RRES adoption using the diffusion of innovation theory and identify key factors that will ensure that the business venture survive for long and is efficiently launched to market using the entrepreneurial process model and lean start-up methodology . This study has five key questions as outlined below:

RQ1: To what extent will the individuals in Midrand adopt the renewable energy system solution at the household level that will determine whether the business venture is viable or not?

RQ2: Which of the five diffusion of innovation attributes will have the most impact on the consumer's attitude towards the adoption of household that will assist with addressing low adoption rate of renewable energy products in Midrand?

RQ3: What are the most important determinants under the diffusion of innovation attributes influencing the individual's attitude towards adoption decision of the renewable energy at the household level that will help with developing a business venture that respond to consumer's demands and needs?

RQ4: Which of those determinants serve as drivers or barriers for consumer's attitude in the adoption decision and has a significant bearing on the business venture viability and success?

RQ5: What are the uttermost important factors to consider that will make certain the business venture survives for long using entrepreneurial process model and is effectively launched to the market using lean start-up methodology?

1.4 Limitations

The scope of the business venture proposal focuses on the quantification of the demand, identifying determinants towards the attitude to the adoption of renewable energy in Midrand in order to develop a viable business venture and ensure that the new venture would survive for long and launch efficiently to the market. Residential sector is the only focus area and other sectors like industrial, mining, commercial, agriculture and rail are not included. Furthermore, the residential area under investigation is Midrand.

Renewable energy technologies only included solar and wind energy as there are the most viable and attractive resources in South Africa. South Africa solar PV and wind resources have the capability to generate globally competitive solar and wind power (Bofinger et al., 2016).

2 Literature review

Prior to the launch, the new business venture must consider the various best practices that relate to the concept of grid-tied renewable system solutions, diffusion of innovation, the adoption and rejection of RESs at the household level, the entrepreneurial process and lean start-up methodology to inform the development of the business venture and assess its prospects of success. A detailed review of the key causes of the electricity shortage crisis in South Africa was conducted, to show the extent of the problem that the business venture proposal is solving and authenticate the business opportunity.

2.1 Electricity shortage crisis in South Africa

Below are some of the key events and failures that has escorted South Africa to the position of electricity shortage crisis:

2.1.1 Adopted electricity policy in 1998 and expected electricity shortage in 2007

A report by Energy (1998) outlined government policy concerning supply and demand of energy for the next decade. Policy statement indicated that due to expected economic growth, South Africa had to add new capacity to the electricity grid by the end of the 1990s. Failure to do so would result in electricity demand exceeding supply by year 2007.

2.1.2 Delays and backtracking in implementing the adopted policy in 1998

To implement the 1998 policy direction various decisions and corresponding actions had to be taken to realise the policy objectives. However, government kept on moving the goal post, at first Eskom was not going to be allowed to invest in new capacity(Van der Heijden, 2013) , but in 2004 government instructed Eskom to start adding its own generation capacity as the private investors failed to come to the market as planned. The initial plan failed because the expected returns in the investment were not attractive enough for private investors to participate due to the low electricity tariffs, and lack of policy and regulatory frameworks for private sector participation (Trollip et al., 2014).

2.1.3 The beginning of loadshedding in 2007 as expected

Joffe (2012) indicated that as a result of a reduced electricity reserve margin due to increased demand comparative to flat supply; shortage of capacity due to delays in new capacity being added to the grid; low coal stockpiles; unusually wet weather; late policy determination for new capacity and a lack of policy implementation caused loadshedding to begun from late 2007 and continued until 2008. Pretorius et al. (2015) states that before and during the electricity crisis in 2007, the electricity reserves dropped to below 15%. This was out of the international best practice tolerable range of 15 – 25 % for electricity reserves.

2.1.4 Electricity crisis moves from bad to worse

Wright and Calitz (2019) outlined how the government planned to respond to the expected supply shortage in 2007. In early 2005, government approved the New Build programme, which consisted of the construction of new capacity that included coal-fired Medupi and Kusile power stations, and Ingula pump-storage system. It also included the recommissioning of previously mothballed coal-fired power stations Camden, Grootvlei and Komati. The New Build programme envisaged for Ingula to commence in 2006, Medupi in 2007 and Kusile in 2009. Medupi's first unit was supposed to be online in 2013, Kusile's in 2014 and Ingula units were to start coming online and be completed between 2013 and 2018. Given the long lag between planning and building of new generation capacity, the construction of the new capacity started too late to prevent the supply shortage anticipated in 2007.

Donnelly (2019) says that Medupi and Kusile were anticipated to address the load shedding challenge once their units start coming online, as of 2020, five of six units of Medupi have come online and three of six units of Kusile have come online. Each Medupi or Kusile unit is rated at 800 MW and as it stands, 6400 MW of 9600 MW new capacity has been connected to the grid from Medupi and Kusile. Furthermore, all four units of Ingula pumped storage scheme that amounts to 1 332 MW are all in operation, and their power output is not enough to close the power shortage gap(World, 2017).

However, the new power stations are performing poorly. Donnelly (2019) also indicated that Medupi and Kusile have a 40% reliability, due to a multitude of design and technical flaws. The 40% reliability is extremely low, most coal-fired power stations have energy availability factor (EAF) between 70% and 90%(Motghare & Chan, 2015). The newer plants like Medupi and Kusile tend to have higher EAF, hence, the 40% is extremely low than the expected performance(Motghare & Chan, 2015). Consequently, the new build programme will not achieve its objectives to stop loadshedding and provides electricity supply security. This creates a conducive environment for new businesses to enter the electricity market.

2.1.5 The return and persistence of loadshedding

From 2009 until 2014, Eskom managed to stop loadshedding, this was because Eskom was paying high energy intensive customer not to use electricity at particular times especially during peak times and postponed planned maintenance in order to keep the lights on. However, the deferral of planned maintenance backfired as the number of breakdowns increased. Load shedding came back again in 2014, for the first time since 2008, it was caused by the depletion of the dry coal stockpiles at some power stations(Lutchman, 2019; Niselow, 2019).

From 2016 until 2018, there was no loadshedding, new build started coming online and increased the capacity to meet the customer's electricity requirements that included 1 332 MW Ingula pumped storage being completed , 800 MW Medupi unit 5 and 800 MW Kusile Unit 1 were synchronised into the grid, and demand reduction due to difficult economic environment(Eskom, 2017).

Eskom (2020) indicates that from 2018 until 2021, loadshedding returned, due to maintenance deferral, lack of mid-life refurbishments, aging power station fleet and poor performance of new power stations. Eskom has a nominal capacity of 45 117 MW with an EAF of 66.64% for financial year 2020 that translate to 29 777MW available to supply the demand. To avoid loadshedding, EAF must be 73%(Transmission, 2019) and an optimal EAF is 80%(Lutchman, 2019). It will take time to improve Eskom's EAF, while Eskom's EAF is low, loadshedding will continue, and this presents a golden business opportunity for the business venture to take-off and capture a significant market share.

2.1.6 Loadshedding intensification

Wright and Calitz (2019) outlined that in 2015, a total of 1325 GWh of energy was lost and a total duration of 858 hours or productive time was lost due to load shedding. In 2016 and 2017, there was no load shedding. In 2018, a total of 192 GWh of energy was lost and a total duration of 127 hours or productive time was lost due to load shedding. In 2019, a total of 769 GWh of energy was lost and a total duration of 272 hours or productive time was lost due to load shedding. This has been the most intensive load shedding experienced in South Africa with 595GWh of 769GWh load shed in one month of March 2019.

Tshwane (2020) indicated that in the year 2020, load shedding moved from bad to worse, the worst in the history of loadshedding, a total of 1500 GWh of energy was lost. Given the current power system performance, South Africa could experience a fluctuating supply shortage between 6GW (stage 6 loadshedding) and 8GW (stage 8 loadshedding). These significant power shortages could translate to between 1700GWh and 4500GWh of energy being lost during load shedding. These will result into households experiencing unplanned, unpredictable and extensive power outages or loadshedding.

2.1.7 Government response, too late too little

Government has responded to the expected short-term electricity crisis, on 07 July 2020, launched The Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) aimed at procuring a total of 2000 MW of utility-scale (more than 50 MW) generation capacity from the private sector. The programme's projects are expected to start commercial operation on 30 June 2022(Arnolodi, 2020).

Although the government has initiated the RMIPPP to procure utility-scale capacity, the long lead-times coupled with the current capacity challenges offers an opportunity for residential based solutions. To provide energy security and reliability for the residential customers in South Africa in the mist load shedding through renewable energy system (RES). The long lead time for bringing the new capacity online, creates a business opportunity for the new venture to be successful as the shortage of electricity will persist.

2.2 Grid-tied renewable energy solutions for the residential sector

2.2.1 Key driver of the residential RES

The residential sector is one of the key contributor of greenhouse gas emissions, making up 30 – 40 % of the global greenhouse gas (GHGs) emissions(Nejat et al., 2015).Coal continues to be a key global energy system, making up 40% of electricity generation and generating more than 40% of the energy related carbon dioxide emission. South Africa along with six other countries (Brazil, China, Germany, India, Russia and US), accounts for approximately 60% of current global GHG emission (BCG, 2018).

In South Africa, more than 82% of the power is generated by coal and this is causing a severe environment degradation. As a result of the dependence and abundance of coal, South Africa is the leading CO_2 emission contributor in Africa and in the top 15 emitters in the world(Bohlmann & Inglesi-Lotz, 2018).

Lakshmi et al. (2012) outlines that the restricted reserves of fossil fuels and the world-wide environment challenge over their use to generate electricity had led to the exploitation of renewable energy resources. The renewable energy plays a significant role in the reduction of Carbon Dioxide (CO2) emission. The emission from burning coal to generate electricity is as high as 1.4 – 3.6 pounds of CO_2E/kWh, while emissions from using renewable energy sources is as little as 0.02 -0.04 pounds CO_2E/kWh(Zeng et al., 2017).

UNFCCC (2015) indicated that the 2015 Paris Agreement fast-tracked the development and adoption of clean energy generation technologies across the world. Its key objective was to foster policies, which would limit the increase in temperature triggered by human influence to below 2 °C.

2.2.2 Potential of renewable energy resources in South Africa

Bofinger et al. (2016) mentions that South Africa solar PV and wind resources have the capability to generate globally competitive solar and wind power. South Africa receives a high degree of sunshine. Most provinces receives an average of 8 -10 hours of sunshine per day, with a national average of 2500 hours per year (Jain & Jain, 2017).

Adedeji et al. (2019) remarks that South Africa has one of the highest solar irradiance and annual horizontal solar radiation in the world. On average daily solar radiation is between 4.5 kWh/m^2 and 6.6 kWh/m^2, which is significantly high compared to 3.6 kWh/m^2 in United States and approximately 2.5 kWh/m^2 in Europe including United Kingdom.

Program (2020) outlines that South Africa is part of 70 countries with excellent conditions for solar PV with a long-term solar PV potential average that surpasses 4.5kWh/kWp per day. South Africa long-term solar PV output average is 5.0kW/kWp.

Over 80% of the land mass has enough wind potential to accomplish a 30% average annual load factor and a total wind power potential of 6700 GW. This is comparable to countries well-known for their good wind resources, like Spain and Germany, their actual average load factors of the full wind fleets are 25 -27% and 20 -23% respectively(Jain & Jain, 2017).

2.2.3 Grid connected (grid-tied) systems

Kaundinya et al. (2009) states that there are two types of grid connected (GC) systems, the first GC system is to supply the local needs for electricity. When there is shortage in generation, electricity will be drawn from the grid and when there is surplus generation electricity will be fed into the grid. The second type is utility scale, decentralised stations are managed by the utilities in the same way as large electric power plant. For the utility scale, any output of the GC system is fed into the central utility grid without considering the local needs.

The GC is the appropriate system as South Africa has a grid, the problem is that the grid is unreliable. The grid-tied RRES has several benefits that include assurance of always having electricity , saving money by using the Eskom's system as back-up as their electricity price is high and expensive, lower equipment and installation cost when compared with the capital , operation and maintenance cost of the off-grid system and has the ability to sell electricity back to the grid(Ghenai & Bettayeb, 2019).

2.3 Renewable energy adoption at the household level

Abotah (2014) notes that when a new technology like RRES is launched, in the beginning it is adopted by a small group of people. The projected number of adopters of an innovation is the market potential. The economic factors have a strong impact on the rate and degree of diffusion for the new technology. A study found that end users are willing to pay additional money for better quality of life, and because of the solar PV energy being green and reliable, there are households willing to pay for it(Vasseur & Kemp, 2015).

Palm and Tengvard (2011) shows that the end users of the solar PV system put more significance on the cost component more than the environmental contribution. It also showed that solar PV system are not aligned to the household priorities, because the key interest of the households in the solar PV is cut cost and save money instead of conserving the environment.

Social acceptance is crucial in the adoption of the renewable energy, customer interaction and satisfaction have a potential to increase the acceptance but the key driver for acceptance is the competitive price(Kapur et al., 2010).In the developing countries like South Africa the absence of awareness for the renewable energy technology among the users is also a key barrier in the adoption decision(Wamukonya, 2003).

2.4 Diffusion of innovation

Rogers (2003) defined the diffusion of innovation (DOI) as the process that individuals in a social system undergo when adopting an innovation like RRES. During the diffusion process the innovation is communicated over time among the individuals of a social system through various communication channels for the them to accept and adopt the innovation.

The DOI theory is applicable when applied to new product launch and when launching the existing product to a new market(Stummer et al., 2015). In this business venture proposal, the innovation part, is the introduction of an existing product into the new market that is the residential sector.

In the business venture proposal, the DOI theory was used to conceptualise and structure the empirical investigations. With the objective to obtain understanding on how the RRES can gain popularity with residential customers in Midrand. The understanding gained will then be used to develop a business venture proposal, which addresses the low adoption rate of renewable energy systems by the residential customers and is attuned to consumer's needs and demands.

2.4.1 Five stages of adoption

Rogers (2003) highlighted that before the potential adopters take a decision to adopt an innovation. There are five stages that they go through that includes knowledge, persuasion, decision, implementation and confirmation. The five stages of how the various communication channels impact the adoption decision is shown in Figure 1 below.

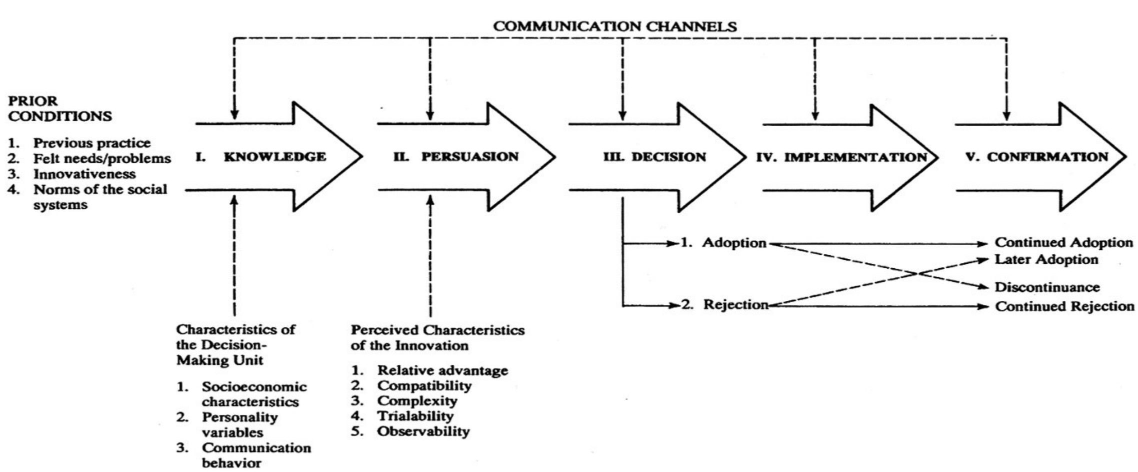

Figure 1: Roger Model for Innovation decision process. Source:(Rogers, 2003).

According to Roger's, the diffusion process assumes that the potential adopters only becomes interested in the innovation after receiving the knowledge about the innovation. From learning about the innovation to persuasion, at this stage, the potential adopter forms a positive or negative attitude towards the innovation. The persuasion stage is based on the five attributes of innovation i.e. relative advantage, compatibility, complexity and trialability and observability. These five attributes will be discussed in detail below and are the ones that the empirical investigation is based on.

In the decision phase, the potential adopter makes a choice to either accept or reject the innovation. If the potential adopter decides to accept the RES, then the next step is to purchase and install the system. If the potential adopter decides to reject the RRES, then it becomes the end of the adoption decision process. At implementation, the adopter buys and installs the RRES. The last stage, the confirmation stage, it is the reassurance and reaffirmation of the adoption choice. In this study, the main focus will be on the persuasion phase, to identify the key determinants and barriers that influence the consumer's attitude towards the RRES. The key determinants and barriers identified will inform the development of the business venture proposal.

2.4.2 Five attributes of innovation

The five attributes play a significant role in evaluating the consumer's attitude on innovation towards adoption. The five attributes are outlined below:

- Relative advantage is the extent the innovation is regarded as better than the related options. These advantages can be expressed as economic profitability, effort saving, convenience or impact, or any form of improvement of the existing services or products. For a diffusion to be effective, innovation like RES at household level must be considered as providing more benefits when compared to the existing products (Eskom supply);
- Compatibility is the level an innovation is consistent with the values, beliefs, needs, and experiences of the public. The public is more probable to be at ease with innovation that is aligned with their values and beliefs;
- Complexity is the degree an innovation is easy or difficult to understand and use. Innovation that are easy are more likely to be adopted than the difficult ones;
- Trialability is the extent that an innovation can be test before adoption. The ability to try the innovation prior adoption reduces uncertainty.
- Observability is the level the innovation can be assessed before adoption. Observing the outcomes of the innovation can reduce uncertainty and lead to adoption.

The innovation having higher relative advantage, compatibility, observability and less complexity are adopted more quickly.

2.4.3 Application of the Diffusion of innovation

For the business venture to be viable, it must address the low adoption rate of renewable energy system by residential customers and must be attuned to the consumer's needs and demands. The five attributes of the diffusion of innovation theory will be used to identify the key drivers and barriers on consumer's attitude towards the adoption of RRES. The insights gained will inform the development of the business venture proposal and leverage drivers and barriers to increase adoption amongst the residential customers in Midrand.

Alrashoud and Tokimatsu (2019) showed that over the years, there has been a significant amount of studies that focuses on the consumer's perspective regarding the adoption of renewable energy technologies. Moreover, the consumer's consumption behavior is one of the most vital factors as it surpasses the ecological limits, and its impact on the depletion of the natural resources. Consumers' adoption to green innovation products and services has been poor, even, when the advantages of the innovative products or services is better than the existing products or services. In South Africa, there are no studies that focused on the consumer's perspective regarding RRES. This study would provide knowledge and understanding on the consumer's views regarding RRES and ultimately that understanding will inform the development of the business venture proposal.

2.5 Entrepreneurial process

2.5.1 Entrepreneurship ecosystem model

Entrepreneurship is a human action in pursuit of creating value through the developing of economic activity, identifying and exploring new industries , markets, processes and products (Ahmad & Seymour, 2008). Entrepreneurship is required in the economy as it plays a vital role of transforming innovative ideas to commercialisation phase.

Isenberg (2011) defined entrepreneurship ecosystem as a group of individual components that integrate in a complex manner enabling growth, enhances job creation and establishes economic stability. An environment in which the individual components interact is known as domains. Isenberg framed six unique domains of the entrepreneurship ecosystem: policy, finance, culture, support, human capital and markets. Entrepreneurial ecosystem explains how a new venture functions in relation to the environment and the effect external factors exerts on the new venture success.

2.5.2 Application of entrepreneurship ecosystem model

The Isenberg framework will be used to evaluate the key factors that the business venture must pay attention when launching the business into the market. According to OECD, globally, less than 50% of start-up last more than five years and few of them become a high-growth firms. While in South Africa, the failure rate of start-ups is between 70% and 80%, which implies that the likelihood of success is extremely low(Fatoki, 2014).

While all the six domains influence the prospect success of the new venture, the business venture proposal will only focus on three most pertinent elements that will determine success and growth of the business. The access to market, human and finances capital are the most crucial for the success and growth of entrepreneurial firms (Foster et al., 2013).

Jin et al. (2019) states that new businesses experience great challenge in accessing the market. To overcome it, new firms must create a considerably new product to overcome the competition posed by the incumbents. Some of the reasons for poor market access include regulation, standards and inadequate market information(Shiferaw et al., 2011).

The human capital plays a crucial role in the failure and growth of a new venture, the entrepreneurs with greater knowledge ,information and experience have greater understanding about opportunities that might lead to a successful new venture than entrepreneurs with less knowledge, information and experience(Bushe, 2019; Rauch & Rijsdijk, 2013).

Access to funding for establishing, maintaining and growing the business is critical(Mason & Brown, 2014). A new business needs different level of funding at various stages of the business development from initiation to decline, when the new venture is unable to get the funding it ends up failing(Bushe, 2019). Most of the new venture fails because of lack of access of funding(MUKUMBA, 2014). The business venture proposal will consider these three factors and develop mitigation to make sure that the new venture grow and become successful.

2.6 Lean Start-up Methodology

Ries (2011) states that the lean start-up methodology is a group of practices that assist entrepreneurs to enhance their probability of creating a successful start-up in response to the high failure rate of new ventures. The lean start-up methodology launches a business model quickly before perfection, get disapproval or validation from the market through the customer feedback and then decide on the way forward earlier before investing more time, effort and financial resources.

The lean start-up approach has five fundamental building block: “finding and prioritising market opportunities in start-ups, designing business models, validated learning including customer development, building minimum viable products and learning whether to preserve with or pivot from the current course of action" (Blank, 2013; Ries, 2011; Shepherd & Gruber, 2020). The business venture will focus on the building minimum viable product that would be launched to the market as soon as possible before investing more time, effort and financial resources.

2.6.1 The minimum-viable-product (MVP)

The minimum viable product is the first product that allows a complete cycle of the Build-Measure-Learn Loop with the least amount of effort, development time and resources(Frederiksen & Brem, 2017). The MVP will only contain the main functionality of the product and its key aim is to test particular hypotheses in the market faster(Blank, 2013). Eisenmann et al. (2012) indicates the test feedback from the MVP, the entrepreneur must take a decision. The decision includes to persevere with the product or business model, or pivot to a reviewed product or business model that alter some aspects while keeping others the same or to perish to leaving the new venture and focus on something else. Figure 2 below shows the measure-learn loop:

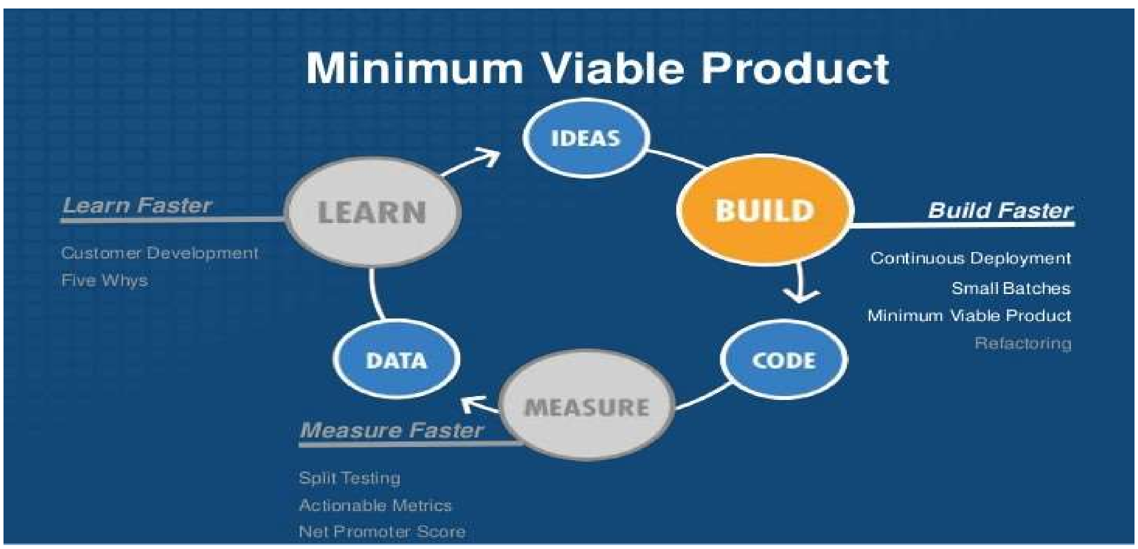

Figure 2:The lean start-up framework build - measure - learn loop(Mpamah, 2015)

2.6.2 Application to WWES

The Lean Start-up approach is relevant to WWES as it provides a scientific method that minimise failure rate and eliminate wastage. WWES does not have the consumer's perception about their services in Midrand, lean will assist in obtaining feedback from the customers.

WWES's founder is bootstrapping operations and will use the lean start-up approach to launch a MVP to start generating revenue as quick as possible. Financial resources will be re-invested into the business to grow the business and improve the product further in-line with the customer feedback.

The MVP will be the existing RES that is still maturing and the value-added services of automation of the customer's property using internet of things. As more research and development is conducted the RRES that includes inverter, solar panels, wind turbine, battery and internet of things components will continue to improve and mature. All the developments and innovations that goes to the market WWES will incorporate them into the offering. Furthermore, the MVP will be applied when the questionnaires are sent out to the houseowners to identify the determinants for consumer's attitude towards adoption of RRES(Polaine et al., 2013). The information received from the respondents will be useful for building the Waya-Waya business model and marketing approach.

3 Research Methodology

The purpose of this section is to outline the research methodology that will be adopted. The research methodology is chosen to generate insights that will inform the development of the business venture. (Bhattacherjee, 2012; Bryman, 2016; Creswell & Creswell, 2017; Flick, 2015; Kumar, 2018; Neuman, 2014) concentrate on the key considerations and approaches involved in the research methodology with regards to the epistemological consideration, ontological considerations. and the theoretical position of the researcher. This chapter will be divided into five key sections that include research strategy (section 3.1), research design (section 3.2), research procedure and methods (section 3.3), reliability and validity measures (section 3.4), and technical and administrative limitations of the research procedure and methods (section 3.5).

3.1 Research Strategy

3.1.1 Description of the research strategy

The research strategy is a clear direction on how to perform a social research, it outlines the connection between theory and research (deductive or inductive), details how researchers will frame their research in their attempt to create or discover knowledge (epistemological consideration) , and specify the nature and existence of objects being researched(ontological consideration) (Bryman, 2016).The research strategy is established on various aspects that include research questions and theoretical frameworks(Wagner et al., 2012).There are three possible strategies that can be adopted: quantitative, qualitative and a mix of both quantitative and qualitative(Bryman, 2016; Neuman, 2014).

3.1.2 Quantitative research strategy

Creswell and Creswell (2017) indicates that the quantitative research is a form of research that describe a phenomenon by collecting numerical data and are analysed using mathematically based methods. Quantitative research is also valuable to measure opinions, attitudes and behaviors and observe how the entire population perceive a certain issue. The ultimate goal of the quantitative research is to find the truth in the sample and infer it to the population.

A quantitative research strategy was adopted, as the study sought to quantify the demand of RES in Midrand, and measure consumer’s attitude to determine how they perceive adoption of residential RES. Descriptive statistics was used as scientific evidence to measure consumer’s attitude(Plonsky, 2015).

Bryman (2016) states that the quantitative research has four basic deliberation: measurement, causality, generalisation and replication. Measurement seeks to determine if the instruments developed measure concepts reliable and valid. Causality aims to explain why things are the way they are, the cause and effect of the variables. Generalisation objective is to assembly a sample that is demonstrative of the population being assessed for the purpose to generalise their findings beyond the conditions of the current study. Replication is the accurate duplication of the previous study. This study replicated two previous studies in the South African context and the aim was not to generalise findings. A deductive approach connecting theory and research was adopted, which aims at testing the existing theories(Bryman, 2016; Neuman, 2014).

Bryman (2016) states that It relies explicitly on scientific evidence like statistics to discover the real or true nature of how society works known as positivism. The nature and the existence of objects, it views social reality as an external and objective reality.

3.1.3 Key learnings from previous studies research strategy

Qureshi et al. (2017) conducted a study to identify determinants that influence the household's decision regarding solar PV adoption in Lahore, Pakistan. A quantitative strategy was selected, and weighted average scores was used for ranking the determinants. The DOI framework was used to identify motives and barriers for adoption decision.

Alrashoud and Tokimatsu (2019) led a study on the factors influencing social perception of residential solar PV systems in Saudi Arabia. The aim of the study was to examine the factors that could motivate or discourage consumer's attitude towards adoption of residential RES. The quantitative strategy was picked and DOI framework used to identify the most important determinants.

3.1.4 Justification for the adopted research strategy

The quantitative research is the appropriate approach as the research questions seeks to quantify the demand of renewable solutions in the residential market and identify key determinants for consumer's attitude towards adoption of RRES. There are already existing theories on renewable energy, innovation and entrepreneurship that the research questions will be tested against. As per the similar studies (Alrashoud & Tokimatsu, 2019; Lee et al., 2018; Qureshi et al., 2017), this study drew lessons from them using the quantitative strategy.

3.2 Research Design

3.2.1 Description of the research design

Bhattacherjee (2012) defined research design as a detailed plan for data collection in an empirical research project. It is a blueprint for empirical research focused at answering research questions or testing specific hypotheses. It must outline at minimum the three key processes: data collection process, instrument development process and sampling process. There are five research designs that can be adopted namely experimental such as the quasi-experiment, cross-sectional the most familiar is survey research, longitudinal, case study and comparative(Bryman, 2016).

3.2.2 Cross-sectional research design overview

This study used a cross-sectional research design. Cross-sectional studies is the studies that covers a sample of a population at a particular time where individuals are asked questions to get a view of the population(Illari & Russo, 2014).

Bryman (2016) states that cross-sectional design is the collecting of data on more than one case at one point in time, the data is collected simultaneously. The aim is to collect quantitative data with respect to a minimum of two variable, to analyse and establish the association between variables. The variables can be a minimum of two, however, the number of cases to be collected should be enough for the researcher to identify the variation in the variables.

Bryman (2016) indicates that variation among cases and association between variables can only be established using a consistent method of measurement throughout, which enable a standardised and systematic method for measuring variation. The cross-sectional design benefit is its ability to identify variation and pattern of association, thus, it was selected for this study. The objective was to use one standardised method for measuring variation in the variables of interest across a population sample from Midrand. Majority of the respondents provided the information that allowed variation among variables to be identified. As a result, it enables the study to identify the key determinants and barriers that influence or hinder the adoption of RRES. In similar studies, this design has been used effectively as shown below.

3.2.3 Key learning from previous studies research design

Zander (2020) led a study to quantify the residential adoption rate in Australia were a cross-sectional design an online survey was used. It was used to provide a quantitative answer and identify motives and barriers in adoption of RRES.

3.2.4 Justification for the adopted research design

Cross-sectional design was selected for its capability to identify variation. In addition, cross -sectional studies is cost-efficient as all measurements was be taken at the same time, offered quick turnaround times and prevented bias in evaluation by standardising (Hulley et al., 2013).

3.3 Research procedure and methods

Research methods comprises of data collection techniques, which will be used to choose cases, quantify, and observe phenomena, collect and process data, analyse data and communicate the findings through a research report(Neuman, 2014). This section will cover the purpose of data collection and analysis (3.3.1), data collection instrument (3.3.2), target population and sampling of respondents (3.3.3), ethical consideration when collecting data (3.3.4), data collection and storage(3.3.5), data, and Information processing and Analysis(3.3.6), description of research respondents(3.3.7).

3.3.1 Purpose of Data Collection and Analysis

Data collection and analysis will be conducted to authenticate whether WWES is a viable business opportunity and identify key drivers and barriers for consumer's attitude towards RRES this will help in developing an effective business venture.

3.3.2 Data collection instrument

A data collection instrument is developed to obtain information that will be essential for the research analysis(Babbie, 2020).For quantitative data collection, there are three types of data collection instruments: interviewing, observation and self-completion questionnaires(Bryman, 2016).

An online survey was used, it was developed using Qualtrics software and sent out to the respondents using digital channels, the email and WhatsApp. Questionnaires are an instrument that comprises the process of asking a sample of respondents the same questions to measure various variables and test

Research collection instruments have various structure depending on the research strategy. Bryman (2016) indicates that quantitative research is highly structured, which enhance the likelihood that the respondents will provide information within the parameters set. There are three types of structures: unstructured, semi-structured, and full structured. A fully structured data collection instrument was utilised were the same questions and order of the questions is the same.

The online survey has two sections the respondent's demographics and innovation attributes questions. The respondent's personal and demographics questions include age, gender, etc. The innovation attributes assessment section obtained data from the households based on DOI attributes to determine consumer's attitude towards RRES adoption decision. Respondents were requested to determine their level of agreement or disagreement on a five-point Likert scale. The Likert scale was selected considering its ability to increase the reliability especially when evaluating attitude and opinions(Joshi et al., 2015).

The research study used previously used survey based on Roger's DOI theory. The survey was adopted from two studies (Alrashoud & Tokimatsu, 2019; Qureshi et al., 2017).Only two determinants were taken from (Alrashoud & Tokimatsu, 2019) study, land use under compatibility attribute and residence location within complexity attribute. The rest were taken from (Qureshi et al., 2017) study. Qureshi et al. (2017) study did not test for reliability and validity as its was to only rank the attributes and determinants. Table 1 below shows DOI attributes with their respective determinants that were tested.

Table 1: The innovation attributes with their respective determinants that will be used to evaluate consumer's attitude towards adoption decision

INNOVATION ATTRIBUTES	KEY DETERMINATS	DEFINITIONS
	·Financial viability	·Price competitiveness of the RES with the existing fossil fuel energy
	·Environmental impact	·Reducing greenhouse emission gas compared to the continuation usage of fossil fuel
	·Socially acceptable	·Trust and acceptance of renewable energy by the community
	·Independence from the grid	·Not affected by the unreliable grid
	·Energy security	·Limitless power from the sun as compared to the limited fossil fuel energy source
Relative advantage	·Technological reliability	·Availability level of the technology when the end users need electricity compared to the existing technologies
	·Installation cost(initial cost)	·Installation cost impact on the current cost of living
	·Social norms	·Alignment of the RRES with the social belief, values and norms
	·Habits and routines	·Household consumption needs and behaviour aligned to the renewable energy generation
Compatibility	·Land use	·Suitability of the RES with the end users living space
	·Knowledge of technology	·Renewable energy knowledge difficult to understand and use
	·Operation and maintenance	·Complexity of using and maintaining RRES
	·Service providers availability	·Difficult to access RRES service providers
	·Residence location	·Renewable energy potential in the identified location
Complexity		
	·People opinions and experiences	·Feedback from existing end users of the performance of RES
Observability		
	·Return warranty over performanc	·Ability to return the RES if not performing well
Trialability		

3.3.3 Target population and sampling of respondents

A target population is all people with the attributes that the research intends to study(Bhattacherjee, 2012) and comprises of the universe of units like people that a sample will be selected from (Bryman, 2016).

The research population was households from Midrand, Gauteng. Midrand was chosen for the following reasons:

- Urban area with a sizeable number of residents owning houses, a population of 87 337; 44.8% of the housing paid off, 97,7% of the dwellings are formal and the total of number of households is 33219(Stats, 2011)
- Majority of the residents are high living standard measure (LSM),Statssa found that majority of the households have house appliances, use electricity for cooking, space heating and lighting, source of water is from local water scheme, use flush toilet, refuse disposal are removed by local authority , 57,3% of the Midrand population has higher education and majority of people are within the income brackets of R307 601 – R614 400 and R614 001 - R1 228 800(Stats, 2011)
- Consumption of electricity in Midrand is high as Statssa outlined that majority use electricity for cooking, space heating and lighting(Stats, 2011)

Sampling is the statistical process of selecting a subset of a population of interest for purposes of making observations and statistical inferences about that population(Bhattacherjee, 2012; Bryman, 2016). Symon and Cassell (2012) states that for quantitative research, there are two types of sampling method, the probability and non-probability sampling. Non-probability technique selects the sample based on a well-thought-out suitability of the units and it is not random. Non-probability was selected for this study because the residents in Midrand could be easily reached by the researcher and had a high chance of participation due to their high electricity consumption and negative impact of loadshedding on their lifestyle.

There are three types of non-probability techniques that can be used for a quantitative research: convenience, snowball and quota sampling(Bryman, 2016; Neuman, 2014). Convenience and snowball sampling was used in the study. Bryman (2016) defines convenience sampling as a sample selected due to their accessibility to the researcher. Whereas snowball sampling, the researcher approaches few individuals who are relevant to the studies to participate and these individuals are requested to approach others to participate. The researcher had a convenient access to the large Midrand population. While for snowball sampling, estate agents as experts were requested to complete the survey and to approach other experts and households to do the same. RAOSOFT online sample calculator was used to determine the sample size, 380 respondents were recommended based on Midrand population size for 95% confidence level.

3.3.4 Ethical consideration when collecting data

Ethics is the adherence to the standards of conduct of the scientific community when conducting a scientific research(Kumar, 2018). See below on how ethical standards were enforced and espoused in this study:

- Participants were made aware that their participation in the research is voluntary;
- Participants were given the Informed Consent form under appendix I, which outright stipulates their right to take part or pull out in the research study;
- The dual principles of anonymity and confidentiality were upheld in accordance to the nature of the research study;
- To ensure anonymity and confidentiality, the introduction of the survey, mentioned that all responses will remain confidential and that the participants will remain anonymous to preserve their privacy;
- The researcher obtained permission from WBS ethics committee to conduct this research study, clearance certificate in appendix V;

- The purpose of the study was shared with the participants and collected data will not be shared with the third parties.

3.3.5 Data collection and storage

The purpose for data collection from the sample is to answer the research questions(Bryman, 2016; Wagner et al., 2012). Data collection is a structured and pre-prepared process that include a comprehensive design of a study, keep a credible record of the data received and verify all the data collected(Neuman, 2014).

All the completed surveys are stored electronically on Qualtrics, after six months there will be destroyed. As described in section 3.3.4, the ethics will be upheld.

3.3.6 Data, and Information processing and Analysis

Data processing is the process of transforming the collected raw information into data(Bryman, 2016). Due to the possibility that the raw data will have errors and missing values, it must be treated or processed before it can be analysed, the treatment of data involve three key steps: coding, entering and cleaning(Neuman, 2014). All the blanks were deleted, and missing data was kept as it was insignificant detailed explanation in section 4.2.1.

3.4 Research Strengths

The results of the research studies is crucial but equally important is the quality of the research, which in a quantitative is determined through the measurement of the reliability and validity (Heale & Twycross, 2015)

3.4.1 Reliability

Reliability is the degree to which the measure of a construct is consistent. The reliability of the data collection instrument outlines the probability of the respondents offering the same answers if the same questions were asked again in a different context(Heale & Twycross, 2015).

Tavakol and Dennick (2011) stated that the Cronbach's alpha, α, measures reliability or internal to see if multiple question Likert scale surveys are reliable. The Cronbach's alpha is expressed as a number between 0 and 1. The acceptable values of alpha is between 0.70 to 0.95 and anything below 0.7 ranges from been questionable, to poor and to unacceptable. Cronbach's alpha was used to measure the reliability of the survey even if the replicated study did not measure it.

3.4.2 Validity

Validity refers to truthfulness, when the validity is not there, it means that there is no acceptable fit between the variable utilised to measure social reality and what is truly happening in the social world(Neuman, 2014).

Heale and Twycross (2015) states that content validity assesses if the measure of attributes or indicator sufficiently covers all the content that it should in relation to the construct. This study used the construct from previous studies (Alam et al., 2014; Qureshi et al., 2017), which makes it content validity.

Missing values also impacts the validity of the empirical results, this study has considered the impact of the missing values and strategies to address the missing values. Acock (2005) mentions that applying ineffective methods to deal with missing values will lead to wrong estimates, slanted statistical power, and unreliable and invalid statistical conclusions.

3.5 Research Weaknesses

Technical and administrative limitations were monitored and treated to ensure research results are reliable and valid.

3.5.1 Technical limitation

See below some of the technical and administration limitation:

- Sampling constraints due to the use of non-probability technique, findings cannot be generalised;
- Questions will be worded properly to eliminate data collection error;
- Online survey with automatic capability was utilised to avoid incorrect that will enable automatic coding and entry of information;
- Respondent error limited be creating a simple and clear survey;
- Standardised instrument to avoid inconsistent.

3.5.2 Administrative limitations

- Missing data was there but was insignificant.

4 Research results

This section presents the empirical results from the data collected from the respondents in Midrand. It includes showing the empirical product of collecting, processing, and analysing the quantitative data. The chapter will be divided into two key sections that include data collection and processing procedure (section 4.1) and data analysis (section 4.2).

4.1 Data collection and processing procedure

A survey research design was used and created on the Qualtrics platform. The survey was sent out on 17 January 2021 and closed on 17 February 2021. A total of 419 responses were received, 98 of which were blanks and thus deleted resulting in 321 cases used for analysis, which is 85% of RAOSOFT calculator recommendation. It was distributed to one of the Estate agencies that requested to remain anonymous and directly to houseowners in Midrand. The survey was distributed using the Whatsapp messaging. A five-point Likert scale was used, where one being strongly disagree and five being strongly agree. The copy of the survey is annexed marked appendix II.

4.2 Data analysis

Data was analysed using the statistical package for the social science (SPSS). Descriptive statistics were used to analyse the data collected. The analysis section consisted of descriptive analysis: missing values, normality test, reliability analysis and exploratory factor analysis using principle component analysis. Subsection below outlines the data analysis performed:

4.2.1 Missing values

There are varying missing data for different questions. There are different reasons for not completing the survey that include refusal to provide information and lack of understanding of the subject matter (Masconi et al., 2015).

Shoemaker et al. (2002) provides the difference between “refusal answers” to the survey questions and “don’t know” answers. Questions that participants refuse to provide information for are the ones requesting for personal information. Whereas questions that receives “don’t know” answers are the ones the participants need to learn and understand the subject under investigation. To limit “don’t know” and “refusal” answers, the survey was simplified to ensure that participants who have inadequate about renewable energy are able to respond. The personal information was asked but the identity of the participants remained anonymous to offer comfort that the personal information will not be shared with third parties. Table 2 below depicts the missing values in the survey:

Table 2: Showing the missing values in the survey

Univariate Statistics

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
Q1	306	1.51	.501	15	4.7	0	0
Q2	321	3.48	.997	0	.0	0	12
Q3	321	3.04	.777	0	.0	9	0
Q4	321	1.33	.710	0	.0	.	.
Q5	312	2.17	.655	9	2.8	.	.
Q6	316	1.21	.409	5	1.6	.	.
Q7	321	2.05	.763	0	.0	.	.
Q8	321	1.15	.357	0	.0	.	.
Q9	321	4.08	1.108	0	.0	32	0
Q10	321	4.01	1.110	0	.0	0	0
Q11	321	3.38	1.199	0	.0	30	0
Q12	321	4.59	.894	0	.0	.	.
Q13	321	4.17	.987	0	.0	19	0
Q14	320	3.82	1.021	1	.3	0	0
Q15	321	2.54	1.369	0	.0	0	0
Q16	321	3.97	1.033	0	.0	0	0
Q17	320	4.48	.856	1	.3	11	0
Q18	321	3.53	1.551	0	.0	0	0
Q19	316	2.90	1.222	5	1.6	0	0
Q20	319	2.50	1.135	2	.6	0	16
Q21	317	3.05	1.167	4	1.2	0	0
Q22	318	4.42	.922	3	.9	14	0
Q23	315	3.48	1.149	6	1.9	23	0
Q24	291	4.08	.951	30	9.3	0	0

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

A total of 321 observations were made, which included category and continuous data. The first seven questions are categorical data that deals with demographics data. An average of 4 items are missing per variable, with gender, annual income and occupancy having the highest missing data. Question 9 to 24 deal with constructs for the DOI analytic framework. Below is an analysis of the missing data as shown in table 2 above:

- Question 1 on gender, 15 items were missing, constitute 4.8% of the total observations. it was the first question, probable reason for not answering is that respondents were uncomfortable. Generally, participants are comfortable with gender related questions and do not take offense, however, prefer a non-verbal collection approach to verbal collection method(Haider et al., 2017). A non-verbal collection method, online survey was used, hence the low level of missing data;
- Question 5 regarding annual income, 9 items of non-response, forms 2.8% of total observation. Annual income is private information, and participants prefer not to share, to avoid the risk of information being shared with third parties (Lustig, 2019). The survey did not

request the identity of the person that might have helped participants to share their information, 97% of the participants shared their income information;

- Question 6, pertaining to the occupancy, 5 items were missing, comprises of 1.6% of the total observation. Occupancy is sensitive information; hence some participants did not give the information;
- Question 8, no missing data;
- Questions 9 to 14 focused on the relative advantage attribute, only one item missing data under technological reliability, overall the response was good as the questions were clear;
- Questions 15 to 18 investigated the compatibility attribute, only one item missing data under habits and routine, overall the response was acceptable as the questions were clear;
- Questions 19 to 22 assessed the complexity attribute, missing data averages 4 item per the determinant, with the highest missing data for knowledge of technology with 1.6%. Participants were now experiencing fatigue due to the long survey;
- Question 23 explored the observability attribute, with 6 items missing. Most people might be staying in area where there are few people with RES and could not answer;
- Question 24 evaluated the trialability attribute, 30 items missing, 9.3% of the total observations, makes it the variable with most missing items in the survey;

Question 24 and 23 had the highest missing data with the number of missing data increasing towards the end of the survey. Most of the people might have not seen the questions and/or were fatigued towards the end of the survey. When more than 10% of data missing on an observation, the statistical analysis and conclusion are more likely to be biased and invalid(Schlomer et al., 2010). The empirical data collected does not have a variable with more than 10% missing data, highest variable of missing data is question 24 on the trialability with 9.3%, which is less than 10%. To preserve the studies confidence level the missing values will be kept in all the analysis.

4.2.2 Participant's demographic profile

The demographic profile is important for understanding the socioeconomic status of participants to determine to whom research findings generalise (Hammer, 2011). The demographic profile of the respondents as shown below on table 3, exhibited that the majority were female, with 50.7% and were 49.3% male, the participation was balanced. In terms of age distribution, the group of 31 -40 years constituted the largest group with 48.3% and second largest was 41 – 50 years group with 26.8%. Most participants have a bachelor's degree that accounts for 52.6% then followed by master's degree and certificate or diploma. The employment rate of the participants is high, with 78.2% of the participants employed and about 6.5% of the participants unemployed. There are 65.1% of respondents that earn between R600 00 - R1 200 000, which are the majority. There are few respondents that earn above R2 500 000 that only accounts for 3.5% of the respondents. Most of the respondents owns the houses that they occupy, with 78.8 % ownership. The dominating number of rooms are 3 to 5 room option.

Table 3: Demographics profile of the sample

Key category	Key options to select from	Number of participants	Percentage (%)
Gender	Male	151	49.3
	Female	155	50.7
Age	20 -30 years	36	11.2
	31- 40 years	155	48.3
	41 – 50 years	86	26.8
	50 - 60 years	32	10.0
	61 – 63 years	7	2.2
	63 years and above	5	1.6
Education Qualification	Matric	9	2.8
	Certificate/Diploma	58	18.1
	Bachelor’s degree	169	52.6
	Master’s degree	80	24.9
	Doctoral degree	5	1.6
Employment status	Employed	251	78.2
	Self-employed	41	12.8
	Unemployed	21	6.5
	Retired	8	2.5
Income	No Income	34	10.9
	R600 000 – R1 200 000	203	65.1

	R1 200 000 – R2 500 000	64	20.5
	Above R2 500 000	11	3.5
Occupancy status	Owned	249	78.8
	Rented	67	21.2
Residential size	Below 3 rooms	74	23.1
	3 – 5 rooms	167	52.0
	5 – 10 rooms	69	21.5
	Above 10 rooms	11	3.4

4.2.3 Demand for renewable energy at household level

Demand for RRES is high, with 85% of the respondents indicating that there are interested. See below table 4, demonstrating the overwhelming positive attitude by respondents towards the renewable energy at the household level:

Table 4: Demand for renewable energy at the household level

Would you be interested in purchasing and installing the renewable energy system at your home?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	273	85.0	85.0	85.0
	No	48	15.0	15.0	100.0
	Total	321	100.0	100.0	

4.2.4 Normality test

Ghasemi and Zahediasl (2012) states that statistical error is prevalent in scientific literature and that approximately 50% of the published articles have at least one error. Statistical methods including correlation, regression, t-test and analysis of variance are established on assumptions, with one being that a random variable is normally distributed. When the assumption is violated, the interpretation and inference might not be reliable or valid. In most cases, normality is assumed without testing the empirical data, but in this study, the normality test was done, to determine the type of statistical procedures to be taken (parametric or non-parametric test). This will ensure that the data is reliable and accurate conclusions can be made. Parametric statistical procedure assumes that the population shows a normal distribution whereas the non-parametric statistical procedure does not make any assumption on the shape of the population(Hoskin, 2012).The Shapiro -Wilk and Kolmogorov – Smirnov test was used to perform the normality test as it has the strongest power in finding significant deviations from normality(D'Agostino, 2017).

Kim and Park (2019) explains hypothesis test for normality test, null hypothesis assumes that empirical data follows normal distribution. Whereas the alternative hypothesis claims that empirical data does not follow a normal distribution. When the p-value is greater than the significance level of 0.05, the decision is to fail to reject the null hypothesis and the conclusion is that data is normally distributed. Whereas when p-value is less than the significance level of 0.05, the decision is rejecting the null hypothesis and the position is that the data is not normally distributed.

From the table 5, the p-value is less than the significance level for all the independent variables against the dependent variable of attitude towards adoption of renewable energy, as a result the data is not normally distributed and a non-parametric approach will used to analyse the empirical data.

Table 5: Shapiro - Wilk test for normality

Tests of Normality

	Is the cheap and affordable price of renewable energy system a key motivation for you to purchase and install it?	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Would you be interested in purchasing and installing the renewable energy system at your home?	Strongly disagree	.492	16	.000	.484	16	.000
	Somewhat disagree	.462	16	.000	.546	16	.000
	Neither agree nor disagree	.469	41	.000	.534	41	.000
	Somewhat agree	.492	102	.000	.485	102	.000
	Strongly agree	.537	146	.000	.290	146	.000

a. Lilliefors Significance Correction

4.2.5 Reliability analysis

Reliability analysis analyses the internal consistency of the evaluation instrument(Gottems et al., 2018), in this case, the online survey. Reliability test using Cronbach alpha must not be done for the whole instrument at once, each construct of the instrument must be tested separately(Tavakol & Dennick, 2011).Reliability test was conducted on each of the five persuasion attributes of Roger's diffusion of innovation theory as required.

The Cronbach's alpha for relative advantage (0.763), compatibility (0.539), complexity (0,487), observability (0) and trialability (0). Relative advantage Cronbach' alpha is greater than 0.7 that make it acceptable. Compatibility, complexity, observability and trialability were below 0.7, which makes them unacceptable.

However, reliability test uses the tau equivalent model, which has two key assumptions that will determine if the valuation accurately shows the empirical data correct reliability, if one of the assumptions is not met, the model will underestimate the true reliability of the empirical data(Graham, 2006). The two assumptions are: if the number of test items are few and if within a construct there are unrelated items, then assumptions of tau model will be violated, and the Cronbach's alpha will be underestimated. Observability and trialability only had one item, hence their Cronbach's alpha was zero. Whereas the compatibility and complexity had four items, which are not few, the issue might be dimensionality (items measure a single construct). There are other measurement models that can be used to test reliability, exploratory factor analysis that uses a more general case will be used(Graham, 2006). The results of the reliability test are shown in table 6 below:

Table 6:A test of the reliability of the key constructs of the survey instrument

Variable	Number of items	Cronbach'α
Relative advantage	6	0.763
Compatibility	4	0.539
Complexity	4	0.487
Observability	1	0
Trialability	1	0

4.2.6 Content validity

Content validity shows the adequacy with which a specific domain of content has been sampled, which expresses if the instrument is a comprehensive measure under study(Alam et al., 2014). The questionnaire is based on the previous research studies on the adoption of renewable energy at the household level (Alam et al., 2014; Qureshi et al., 2017), as a result, it shows content validity.

4.2.7 Exploratory Factor Analysis using principle component analysis

Exploratory factor analysis creates a simple structure by identifying the items that load together or belong to the same construct through a rotated components matrix. Principle component analysis was conducted to form clusters of variables with common themes and to determine the most valuable DOI attributes in the adoption of renewable energy.

Corner (2009) indicates that there are two types of rotational method used in the factor analysis, which are orthogonal or oblique. The orthogonal rotation posits that the factors in the analysis are uncorrelated. Some of the orthogonal methods include varimax, equamax and quartimax. While oblique assumes that the factors in the analysis are correlated and various methods includes direct oblimin and promax.

Tabachnick et al. (2007)suggested the optimal way to decide which rotation method to use between orthogonal and oblique, is to run the oblique rotation with the selected model and assess the correlation among the factors. In the case where the factor correlation matrix is below 0.32, the decision should be to use orthogonal method. When the correlation matrix is 0.32 and above, decision is to use oblique method. See below table 7 that shows the results from the oblique rotation method:

Table 7:Oblique results for deciding which rotated matrix method to use in the factor analysis

Component Correlation Matrix

Component	1	2	3	4	5
1	1.000	-.014	.291	.250	-.025
2	-.014	1.000	-.149	-.060	-.065
3	.291	-.149	1.000	.185	-.046
4	.250	-.060	.185	1.000	.019
5	-.025	-.065	-.046	.019	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

The orthogonal rotation method will be used as there is no correlation that is 0.32 and above in table 8. In SPSS, there are three options for the orthogonal matrix, varimax method was selected because it has proven to be the most effective method in identifying clusters and it is highly recommended by researchers and test developers (Laher, 2010).

Table 8 below shows the outcomes of the rotated components matrix using the principal component analysis with varimax rotation. The complete rotated matrix tables is in appendix IV. Once the factor analysis is completed, factor loading higher than 0.6 are classified as high, between 0.3 and 0.6 are moderate high and the cut-off point is an variable below 0.3(Laher, 2010).

The varimax values of the questionnaire items above 0.3 were kept and items with a loading of less than 0.3 were removed to simplify the model. The variable highlighted in light grey below will be removed. Convergent and discriminant validity for testing the construct validity are acceptable for items with loading equal or greater than 0.3.

The ranking based on the explained variance, relative advantage described the biggest change in variance followed by compatibility, complexity, observability and trialability. The ranking based on the mean of the responses, relative advantage ranked first then followed by compatibility, complexity, trialability, and observability. The ranking based on the explained variance and mean is the same for relative advantage, compatibility and complexity. Whereas it is different for observability and trialability. However, considering the reliability test, variance explained percentage and eigenvalue, observability and trialability are not major attributes for consumers to choose the adoption of RES at household level.

With regards to identifying the key determinants and barriers, the mean value of the questions will be used. For relative advantage, independence from the grid or loadshedding is the key determinant, followed by energy security, financial viability, environmental impact, technology reliability and social acceptance. However, independence from the grid had a factor loading of 0.142 that is within the cut-off area, it is discarded that makes energy security the key determinant.

In relation to complexity, habits and routines is the main determinant, succeeded by installation cost, social norms and land use. Both cost of installation and land use have a factor loading below 0.3 and were eliminated after the factor analysis. As a result, habits and routine and social norms are the two determinants.

For complexity, operation and maintenance is the leading barrier, then come knowledge of technology, service providers and residence location. Residence location determinant has factor loading below 0.3 and it is within the cut-off area. However, majority of the respondent's location have great potential for renewable energy.

Observability and trialability have low eigenvalue and variance explained in percentage they will be removed from the model. However, people's opinion and experience under observability does not have an impact on the respondent's decision to adopt the renewable energy at household level. Return warranty over performance under trialability is an important factor for respondent, majority of the respondents strongly agree that the ability to return the system if not working well will influence their decision to purchase and install the RES.

Table 8: Factor analysis using principle component analysis for the DOI attributes

Innovation Attributes	Key determinants	Loading	Var.explained (%)	Mean	Median
Relative advantage	• Financial Viability	0.304	23.9	4.05	4
	• Environmental impact	0.786	12.4	4.00	4
	• Socially acceptable	0.732	7.9	3.35	3
	• Independence from the grid	0.142	7.3	4.60	5
	• Energy security	0.554	6.7	4.20	4
	• Technological reliability	0.496	5.6	3.80	4
Compatibility	• Installation cost (initial cost)	0.001	5.1	2.54	1
	• Social norms	0.515	4.3	3.98	5
	• Habits and routines	0.612	4.2	4.52	5
	• Land use	0.193	3.7	3.53	5
Complexity	• Knowledge of technology	0.775	3.6	2.90	4

	• Operation and maintenance	0.780	3.5	2.44	3
	• Service providers availability	0.755	3.1	3.00	3
	• Residence location	-0.027	3.0	4.44	5
Observability	• People opinions and experiences	0.431	2.6	3.49	3
Trialability	• Return warranty over performance	0.227	2.2	4.08	5

Figure 3 below illustrates eigenvalues for the variables that provides amount of variance explained by the factor. Relative advantage as mentioned above is the leading attribute then followed by compatibility, complexity, observability and trialability.

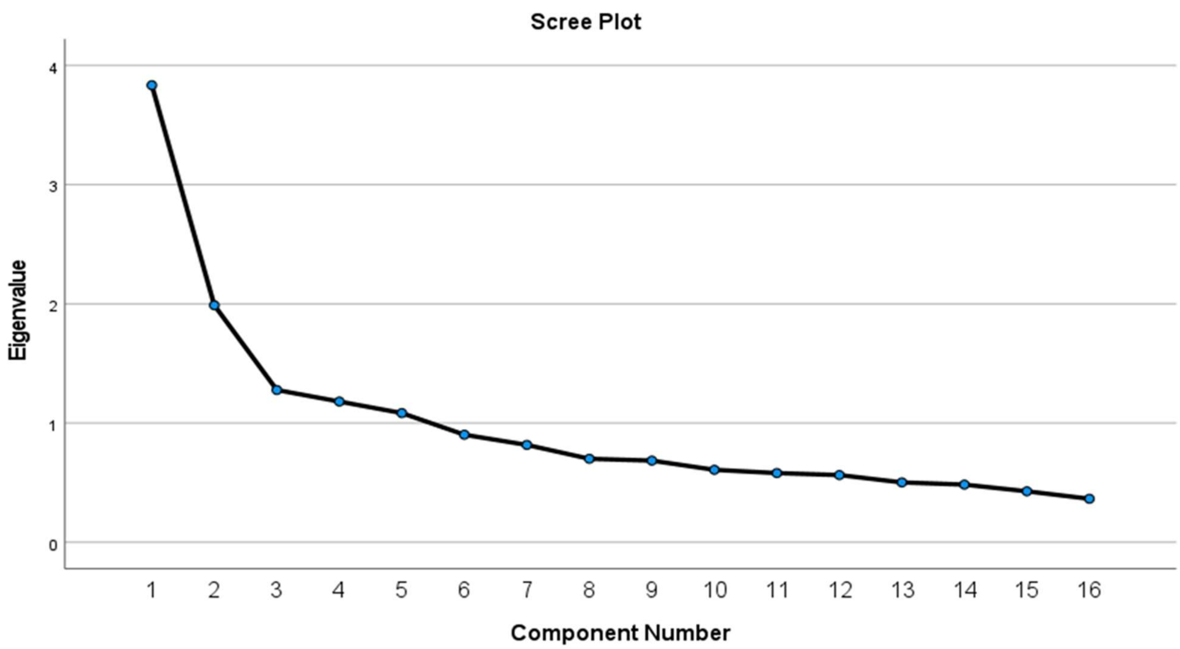

Figure 3: Eigenvalue graph for the DOI attributes

The sampling adequacy of the correlation matrix is determined by Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett sphericity test(Budaev, 2010). KMO measure of sampling adequacy was found to be 0.786 - which is acceptable, as it significantly exceeds 0.5(Budaev, 2010). While Bartlett's test of Sphericity is significant for both 99% and 95% confidence level. The null hypothesis that all the correlations are zero is rejected as the p-value is less than 0.05(Budaev, 2010).The DOI attributes are not correlated and are measuring distinct construct. See the outcome of the KMO and Bartlett's test below in table 9:

Table 9:KMO and Bartlett's test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.786
Bartlett's Test of Sphericity	Approx. Chi-Square	935.622
	df	120
	Sig.	.000

5 Discussion of research findings

This section interpret and discuss data analysis in chapter 4. The research questions will be answered and discussed in detail. The chapter has three sections, key findings from empirical data analysis (section 5.1), comparing the empirical results with other studies (section 5.2) and application of the findings on the business venture proposal (section 5.3). The results will be used to develop a business venture that is viable and atunned to consumer's needs and demand.

5.1 Key findings from data analysis

Key finding from the empirical investigation and answers to the business venture proposal research questions will be shown below:

RQ1: To what extent will the individuals in Midrand adopt the renewable energy systems at the household level that will determine whether the business venture is viable or not? A compelling majority are interested in the household RES, 273 of 321(85%) respondents, want to purchase and install the system. This a good indication that there is a business need and opportunity in Midrand for installations of RES.

RQ2: Which of the five diffusion of innovation attributes will have the most impact on the consumer's attitude towards the adoption of household RES that will assist with addressing low adoption rate of renewable energy products in the residential sector? Relative advantage is the most important attribute in influencing consumer's attitude in adopting household RES. Then followed by compatibility and complexity. Observability and trialability are the two least important attributes. When developing marketing strategies, it would be crucial to amplify relative advantage, compatibility and complexity in the messaging.

RQ3: What are the most important determinants under the diffusion of innovation attributes influencing the individual's attitude towards adoption of household RES that will help with developing a business venture that respond to consumer's demands and needs? The top three most important determinants under the relative advantage attribute are energy security, financial viability and environmental friendliness. For compatibility, the top 2 are: habits and routine and social norms. While for complexity, the majority neither agree nor disagree that operation and maintenance of RES is difficult and service providers are hard to find. This shows that there is a gap in the market, few people know about RES and service providers are not creating enough awareness and visibility for their services.

RQ4: Which of those determinants serve as drivers or barriers for consumer's attitude in the adoption decision and has a significant bearing on the business venture viability and success? Independence from grid was the key driver but had a low factor loading and installation cost was the key barrier also had a low factor loading. Knowledge of technology was the one and only barrier, educative advertising will be required to increase awareness and knowledge about RES in order to increase consumer positive attitude. Table 10 below shows driver and barriers for adoption in Midrand:

Table 10: Depicts drivers and barriers for RES adoption

DRIVERS	BARRIERS
• Energy security	• Knowledge of technology
• Financial viability	
• Environmental friendliness	
• Habits and routine	
• Social norms	

RQ5: What are the uttermost important factors to consider that will make certain the business venture survives for long using entrepreneurial process model and is effectively launched to the market using lean start-up methodology? The access to market, human and finances capital are the most crucial factors for the success and growth of entrepreneurial firms that were identified using the entrepreneurial process model. To ensure that minimum time, effort and resources are used, in accordance to the lean start-up methodology, the existing renewable energy system in the market that is fused fourth industrial technologies will be launched. This will enable the business venture to start generating revenue and at the same time start collecting inputs from the customers on how to improve the RRES product.

5.2 Comparing the empirical results with other studies

5.2.1 Relative advantage

Key drivers in their order of importance of the respondents in Midrand: Independence from the grid, energy security, financial viability, environmental impact, technology reliability and social acceptance.

5.2.1.1 Independence from the grid

Most participants strongly agree that loadshedding will be a key driver for adoption. Loadshedding will fast-track the adoption of RRES in Midrand. In Sweden, power failures that were becoming frequent were found to be a key motive for adoption (Palm & Tengvard, 2011). In Pakistan, loadshedding was also a key driver for adoption of RES especially in Urban areas(Qureshi et al., 2017).

5.2.1.2 Energy security

RES has zero marginal cost as they do not require fuel to produce electricity and are inexhaustible, however, a downside is that there are purely dependent on the weather (non-dispatchable)(Lucas et al., 2016). Despite its non-dispatchable nature, which can be mitigated by installing a storage system, majority of the participants agree that RES energy security is a key driver for adoption. It rates higher than financial viability and environmental friendliness.

5.2.1.3 Financial viability

Jacobsson and Lauber (2006) embarked on a study to discover the reasons for an accelerated diffusion for solar PV and wind energy in Germany. One of the key findings was that although the renewable energy technologies are socially acceptable due to the impact on the environmental challenge that the world is facing, the key determinant was found to be largely economic feasibility. Although, financial viability is not the most important determinant, majority of the respondent agree affordable prices of RES will increase adoption. As it stands, there are no financial incentives from government like tax rebates for adoption of RRES. Countries like Germany, Italy, USA, Japan and China increased the adoption of RES by offering financial incentives(Richter, 2013).

5.2.1.4 Environmental friendliness

Environmental friendliness is the most popular driver for adoption of RES (Balcombe et al., 2013), however, in Midrand respondents consider it an important determinant but not top in their list. Palm and Tengvard (2011) performed an analysis on motives for and barriers to household adoption of small-scale production of electricity in Sweden. Key finding was that environmental concerns are the central motive for adopting renewable energy technologies and will reduce the usage of fossil fuel.

5.2.1.5 Technological reliability

Technological reliability is a key factor but was the second least factor under relative advantage attribute. A study in UK focusing on understanding drivers and motives given low uptake despite a substantial financial support from UK government, found that uncertainty and doubt about the technology was a barrier.

5.2.1.6 Social acceptance

Majority of the respondents neither agree nor disagree on the importance of social acceptance. The knowledge about RES is still low and social acceptance has not gained its full power. A study in Australia found that social interactions played a vital role in decision-making(Simpson, 2018). While in UK it was established that passive peer effect of observing solar PV system in the community was less crucial than active effect through direct interpersonal contact(Palm, 2017).

5.2.2 Compatibility

5.2.2.1 INSTALLATION COST

Respondents consider installation cost for RES as high and is one of the main barriers in the adoption of RES. Vasseur and Kemp (2015) evaluated the factors behind the adoption and non-adoption of solar PV in the Netherlands. The main finding was that the cost of the solar PV system was the key determinant driving the adoption decision for both adopters and non-adopters. From the adopter's perception, the cost of the system is affordable whereas from the non-adopter it is expensive. In Sweden, the major barrier was cost, most individuals considered the RES for household expensive and they rather contribute to green electricity in other ways(Palm & Tengvard, 2011).

Ugulu (2019) identified barriers and motivations for solar PV adoption in urban Nigeria, where over 50% of the household depends on self-generation using expensive petrol- and diesel-powered generation. High capital cost and lack of financing were the two main barriers in the adoption of the solar PV.

5.2.2.2 SOCIAL NORMS

Majority of the respondents strongly agree that RES is aligned to their belief. A study in Mexico found that personal norm influence the decision to adopt RES(Reyes-Mercado, 2017).

5.2.2.3 HABITS AND ROUTINES

Eskom was once the Utility with the cheapest electricity in the entire world. For the past 10 years ,there has been a significant increase in the electricity tariff of 356% against an inflation of 74%(AIDC, 2020). Majority of the participant strongly agree that the reduction of electricity is a key determinant given that Eskom is not providing price certainty and predictability. A study in Finland indicated that the residents were adopting RES to hedge against the future price increase(Juntunen, 2014), which is more likely to happen in Midrand.

5.2.3 COMPLEXITY

5.2.3.1 Knowledge of technology

Claudy et al. (2010) conducted a study on the consumer's awareness of microgeneration technologies in the Republic of Ireland. The findings indicated that the awareness was different between the technologies and customer segments. The analysis revealed that only 18% of respondent had heard about micro combined heat and power generation and 80% were aware of solar PV panels. It is vital to know the stage that the customer is at in order to create impactful communication to them. Most respondents have little knowledge about RRES, an awareness campaign must be launched.

5.2.3.2 Operation and maintenance

Participants neither agree nor disagree on their view regarding the use and maintenance of RES. Educational marketing and advertising about RES is still lacking as majority of participant cannot provide a concrete view about it. However, perceived difficult in maintenance and hard to use system will be a barrier for adoption(Palm, 2018). Simplification and disseminating the right information will be key in order to increase the adoption level.

5.2.3.3 Service provider availability

High number of service providers will increase competitiveness and overall increase adoption. There is little advertising and marketing by service providers, which can be observed from the participants response, majority of them neither agree nor disagree. In Sweden, at early stage of their adoption, there were only two key players in the market, as government introduced subsidies, the adoption level started increasing and at the same time the number of service providers also increased significantly, and that fuelled adoption even further(Campoccia et al., 2014).

5.3 Application of the findings on the business venture proposal

The empirical results show that majority of the participants in Midrand are interested in buying and installing RRES. There is a serious need in the market for the business venture and it is validated by the overwhelming interest shown by the respondents.

The outcomes of the DOI show that relative advantage, compatibility and complexity are the key attributes that influences consumers in Midrand to buy and install RRES. These three attributes were prioritised in developing the business venture. The key determinants under these attributes informed key elements of the business venture.

RRES attributes are well-aligned with the key determinants of the participants. RRES has a capability to secure energy security and inherently provides a positive environmental impact in the reduction of the GHG emissions. The RRES product has attributes that influences the consumers to buy and install them, this will go a long way in addressing the low adoption rate that was observed in the past.

The price of RRES is also a key determinant in buying the RRES. Majority of the participants indicated that the cost of a renewable energy system that is between R 120 000 and R300 000 is not aligned to their current cost of living. However, given the high quality of the equipment will be offering, the business venture opted for R131 065.

Majority of the participants’ consumption need, and behaviour is well aligned to the renewable energy generation, which makes it an attractive product especially with the storage facility. Majority of the participants social belief, values and norms are well compatible with the RRES. This increases the likelihood that the consumers will buy and install RRES, which will increase sales and eventually make the business venture viable and successful. Marketing strategies and messaging will leverage the habits and routines and social norms determinants in developing them.

Majority of the participants neither agree nor disagree that the operation and maintenance of RRES is difficult. RRES will be fused with fourth industrial technologies that will make it user friendly for the consumers to use and maintain their systems. Furthermore, majority of the participants indicated that it is difficult to find the service providers for RES. The business venture will embark on huge campaigns to create awareness and visibility of services available in the industry.

To get access with the market, the business venture will satisfy the licensing and registration requirement as outlined by NERSA, personal information protection and management requirements and key accreditation. The issue of funding, the owner will be bootstrapping the first phase of the business to limit financial exposure risks. The human capital will ensure that highly skilled individual is utilised to build the business venture. To minimise wastage on time, effort and financial resources, the existing MVP coupled with fourth industrial revolution technologies will be launch to the market as soon as possible.

6 The Business Venture Plan

6.1 Company's overview

Who WWES are and their key drivers is outlined in Figure 4 below:

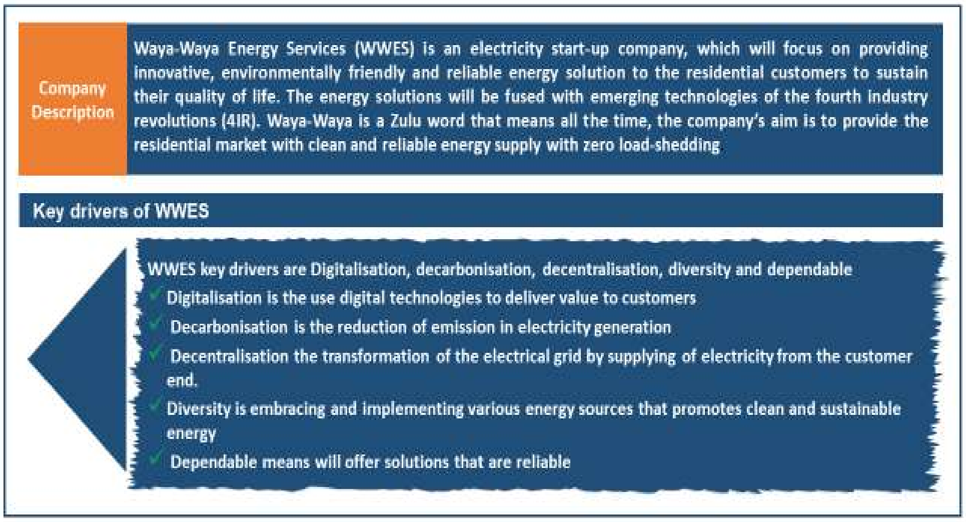

Figure 4: WWES Company's description and key drivers. Source: Author's own

6.1.1 WWES's strategic direction

WWES's key strategic direction and pillars depicted in Figure 5 below:

Figure 5: WWES's strategic direction. Source: Author's own

6.1.2 Uniqueness of WWES

A VRIO analysis for WWES capabilities was performed to determine its strategy uniqueness and it was found to be temporary competitive advantage. WWES will be the only company using 4IR for customer service and marketing, this gives it a temporary competitive advantage, as competitors with right skills could develop this capability. Below Figure 6 shows VRIO analysis:

Figure 6: VRIO analysis(Johnson et al., 2011). Source: Author's own

6.2 Situational Analysis

6.2.1 Residential Renewable Energy Industry

The residential renewable energy industry is relatively new in South Africa with a huge growth potential. NERSA does not require renewable energy installation lower than 1 MW to be registered including households, thus there is no official information of the total residential renewable energy installed capacity.

However, different publication has been estimating the existing installed and future installed capacity. Transmission (2019) mentions that according to Power Quality Renewable Service 2016, an estimated amount of rooftop PV of 154MW was installed in 2015, which include commercial, businesses and residential. In 2018, an estimated amount of rooftop PV installed in South Africa was 584MW. The Eskom Medium Term System Adequacy Outlook (MTSAO) 2019 sets the threshold to 500 MW per annum that will be achieve in 2023.Figure 7 below shows the cumulative rooftop capacity assumed in the MTSAO 2019(Transmission, 2019).

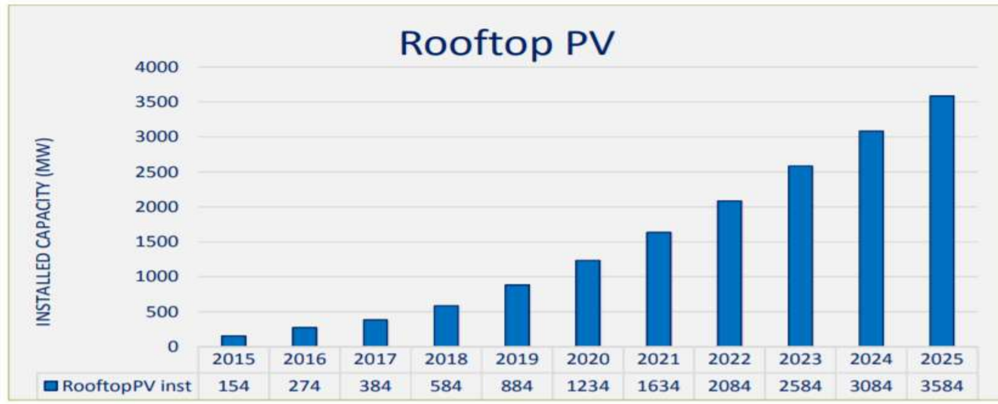

Figure 7:Estimated Rooftop PV Capacity. Source: (Transmission, 2019)

The total estimated available market for solar rooftop PV systems installed in the country, energy storage and capital leveraged in energy efficiency interventions implemented by South African energy users is valued at an approximately R125 billion by 2035(Muringathuparambi, 2020).

6.2.2 Grid Tied Renewable Energy Solutions for Residential Customer

WWES will use 4IR to conduct its services in order to offer great customer experience. The 4IR will be used as follows: firstly, Internet of things (IoT) technology will be used to monitor and control all the appliances, entertainment systems, lighting and security system remotely, all objects like appliances in the house will have a unique IP address assigned to it, each appliance would be accessed through the internet by homeowner(Al-Ali, 2015, 2016).Figure 8 below shows the overview of internet of things and key benefits that the Waya-Waya customers will derive from purchasing the system.

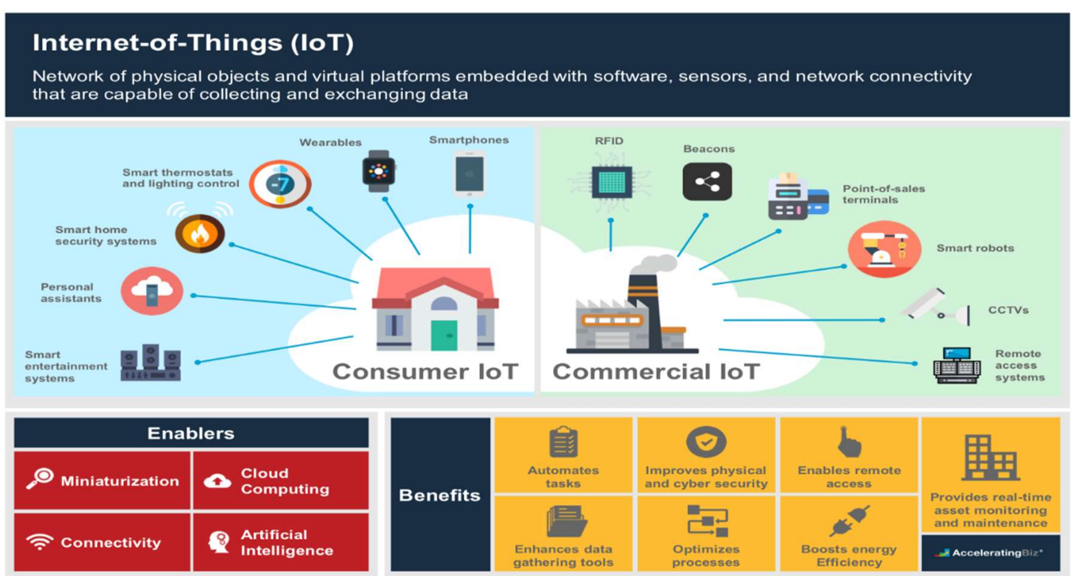

Figure 8:Overview of Internet of Things. Source: (Kibria et al., 2018)

Secondly, artificial intelligence technology (AI) will be used to automate data analysis and visualisation for the customer generation and consumption data(Kibria et al., 2018). AI will be used for the modelling and design, optimisation, estimation and management of RES(Kalogirou, 2001). For example, during the operation of either the solar or wind generation system the AI will monitor the health of the solar and wind generation key parameters(Bose, 2017).

6.2.3 Market/Industry analysis

The industry has a huge potential of growth considering the environmental and electricity shortage challenges that are facing the country. The barriers to entry are high and will limit the competition. See below figure 9 outlining Porter's five forces analysis:

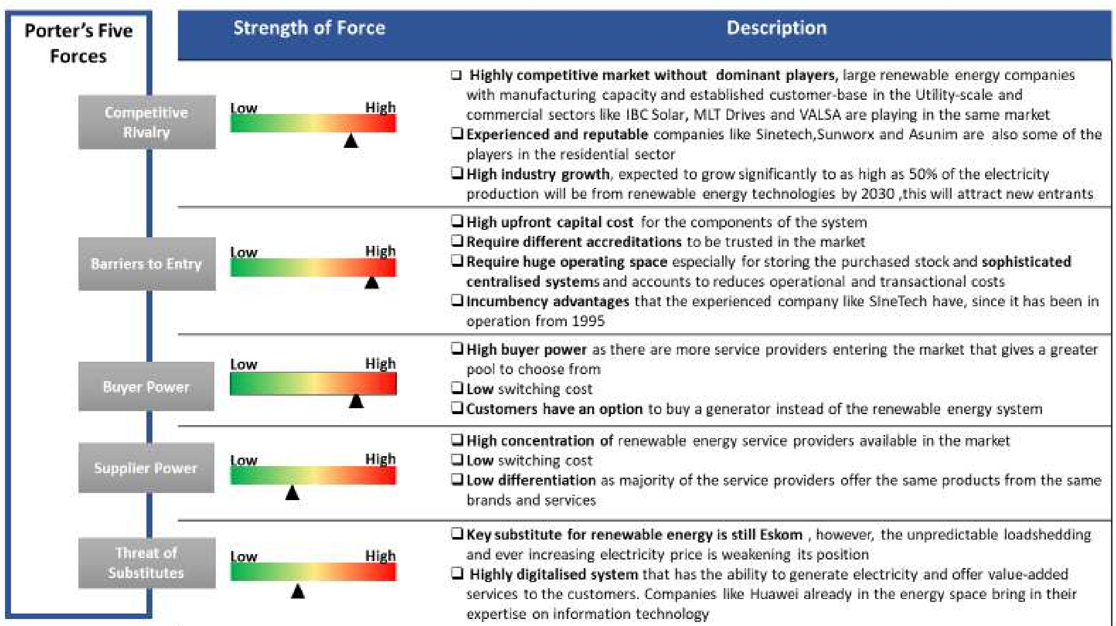

Figure 9:Porter's five force analysis for the residential renewable energy market. Source: Author's own

6.2.4 Competitor Analysis

WWES's traditional competitors include: Genergy, Sinetech, Valsa, etc. The industry is attractive as it has attracted big international companies in the market like IBC SOLAR and AVENGA wind Energy, see below Figure 10 indicating local and international competitors.

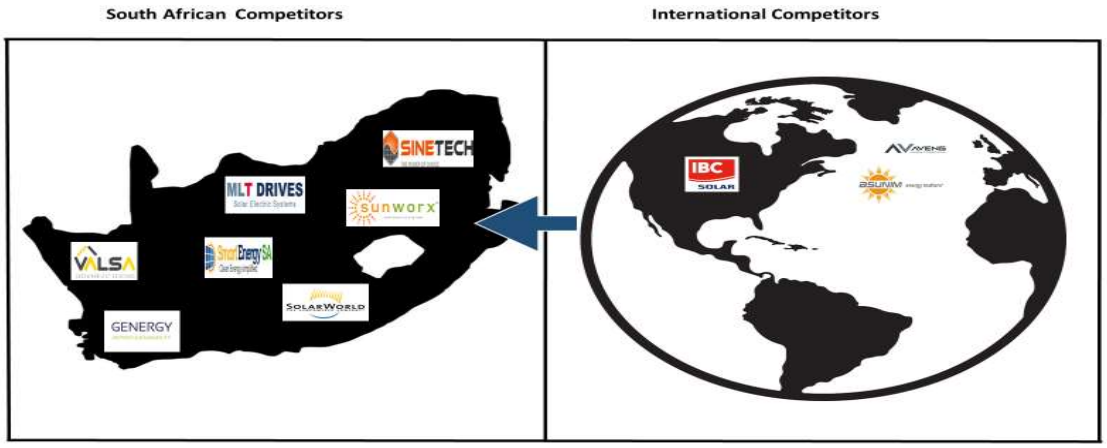

Figure 10:South Africa and International competitors. Source: Author's own,(SolarWorld, 2021),(SineTECH, 2021),(Asunim, 2021),(Aveng, 2021), (Genergy, 2021), (VALSA, 2021), (SA, 2021), (IBC, 2021),(SineTECH, 2021), (Power, 2021) and (Sunworx, 2021).

Votteler et al. (2014) mentions that high quality products are gold in the residential renewable energy industry, to grow the customer base. However, most new entrants like WWES usually offer cheap products, which creates a bad reputation due to poor performance of the products. Companies either source their products from different manufacturers or manufacture it themselves like Valsa and IBC Solar. Most companies source their equipment abroad. WWES will offer high quality products for competitive parity and will source products from local supply to avoid additional cost and reduce lead time for delivery. WWES competitive advantage is the use of 4IR for end-to end customer service and marketing, which the other players are not currently doing. See figure 11 for comparative analysis:

COMPETITOR ANALYSIS AND COMPARISON

COMPETITORS	Financing	Distribute	Consultation & design	Installation	Using 4IR for customer services	Use High Quality Products	Accreditation for quality	Marketing using 4IR
WAYA WAYA	×	×	✓	✓	✓	✓	✓	✓
GENERGY	✓	×	✓	✓	×	✓	✓	×
VALSA	×	✓	✓	✓	×	✓	✓	×
Smart Energy SA	✓	✓	✓	×	×	✓	✓	×
IBC SOLAR	✓	✓	✓	✓	×	✓	✓	×
SINETECH	×	✓	✓	✓	×	✓	✓	×
MLT DRIVES	×	✓	✓	✓	×	✓	✓	×
sunworx	✓	✓	✓	✓	×	✓	✓	×

✓ Waya -Waya's Point of Differentiation ✓ Capability present × Capability present

Figure 11: Competitor analysis and comparison. Source: Author's own,(Genergy, 2021), (VALSA, 2021), (SA, 2021), (IBC, 2021),(SineTECH, 2021), (Power, 2021) and (Sunworx, 2021)

6.2.5 6W's Customer Analysis

6W model of customer analysis was performed to provide insights into the customer needs. See below Figure 12:

Figure 12: WWES's 6Ws Customer Analysis. Source: Author's own

6.2.6 Product Portfolio Analysis

WWES's product portfolio is business-to-consumer (B2C). The B2C stream consists of two key solutions, grid-tied system without energy storage and grid-tied system with energy storage. The grid-tied system with storage is recommended, as it can counter the erraticism in solar PV production due to changes in the weather. It also ensure that solar PV is able to supply electricity during morning (06:00 – 09:00 AM) and evening (18:00 -21:00PM) peaks, normally the highest solar PV generation is during the mid-day when solar irradiance is at optimal and household most of the electricity is used during peak hours.

6.2.7 SWOT Analysis

Strengths	Weaknesses
❖ WWES does not have any legacy issues and can implement their 4IR strategy with no obstacles ❖ Providing high quality equipment ❖ Adopting future of work strategy to reduce manpower and overhead costs ❖ Offer personalised and quick turnaround marketing that has the ability to track conversion rates from interest to purchase	❖ Poor awareness of WWES ❖ New brand still growing through the first stage of development ❖ Weak financial position and can't offer financing to customers ❖ Only offer grid-tied solutions ❖ Still have to apply for various accreditation ❖ Customer sector only limited to residential and does not include commercial and businesses

Opportunities	Threats
❖ On-going loadshedding a key driver for alternative electricity source ❖ Renewable energy are sustainable and will eliminate fossil fuel dependence ❖ Low maintenance cost of the renewable energy ❖ Reduce electricity bill given the perpetual electricity increase from Eskom ❖ demand and consumption of electricity is expected to grow at a faster rate ❖ Climate change drive sustainable solutions that includes renewable energy	❖ Renewable energy systems are weather dependent ❖ Solar energy storage is experiencing a decline in cost but still expensive ❖ Some of the equipment material are not recyclable and causes pollution ❖ Risk of cyber attacks ❖ Data is still the most expensive when compared to other African continent especially for mobile communications ❖ Depressed South African Economy

Figure 13: SWOT analysis for internal and external environment. Source: Author's own

6.2.8 Ansoff Matrix

WWES is launching an existing product into a relatively new residential market, market development. The plan is to first build a good customer- base in Midrand, spread the services across entire Gauteng (market penetration), add more services and product, and then diversify into manufacturing of renewable energy equipment. Figure 14 below shows how the Ansoff matrix will be applied at WWES:

Figure 14:Ansoff matrix application to WWES. Source: Author's own

6.3 Marketing

6.3.1 Primary marketing objective

WWES's primary marketing objective is to foster product awareness and drive sales using traditional and digital marketing strategies.

6.3.2 Primary target market

The target market is the middle- and high-income residents that are seeking energy security and high-quality lifestyle without loadshedding. These consumers have medium to high electricity consumption and have an ability to overcome the high initial cost of the system.

6.3.3 Positioning in the market

WWE seeks to provide reliable energy to residential market starting with Midrand through 4IR infused customer experience. WWES wants to be the go-to service provider for household RES. The application process will be quick and personalised, and installed system will be high quality.

6.3.4 Marketing Strategy – Marketing mix

Marketing mix consists of product, promotion, price and place(Išoraitė, 2016). Grid-tied renewable system features will include a free IoT system that will enable the customer to have full remote access to all the appliances in the house from anywhere. To attract customers the IoT will be installed for free to customers. Social media will be a key lever to raise awareness about WWES's solutions. Pricing will be total capital cost plus a 10% premium for services. See below figure 15 on marketing mix:

Figure 15: WWES's Marketing Mix. Source: Author's own

6.4 Operational Plan

6.4.1 Business location analysis

WWES will be a digital company without offices, all operational processes, customer experience and business model will be digitalised (Westerman et al., 2014). Employees will work remotely as a strategy to align with the future of work (Forum, 2020). Equipment will be ordered after getting an order and payment to avoid inventory management that will require storage facilities to effectively manage them.

6.4.2 Operating equipment

The equipment requirements of WWES business will be solar PV and wind energy systems. However, in this section on the solar PV equipment will be covered given that Gauteng will be the first province to launch. Solar PV system main components are solar panels, multi-mode inverter (grid-tied inverter) and battery bank.

The selection of the best grid-tied system is complicated requiring the end-user to consider several factors and must be done by a qualified engineer. The grid-tied system has key components that must be sized correctly otherwise the system performance becomes poor and inefficient and the value of the system is lost(*Cleanenergyreviews*, 2020). WWES will make it easy for the users to choose the best grid-tied system.

6.4.2.1 Solar PV system operation

Solar PV panels captures the sun’s energy and convert solar radiation into electricity(Awasthi et al., 2020). In electricity there are two types of currents, direct current (DC) and alternating current (AC)(Planas et al., 2015). DC is the flow of electrical charge in one direction and is produced from batteries and solar cells. While AC changes direction, AC changes direction 50 times per second, thus frequency is 50 hertz(*Howstuffworks*, 2020). Appliances and household supply use the AC system. Solar panel will produce DC, inverter will convert DC to AC to match the current of the appliances in the house. Charger controller regulates the battery to ensure that it does not overcharge. Battery bank is to store and produced electricity when required. From an inverter electricity is supplied to the house for usage. Figure 16 below shows how the solar system works:

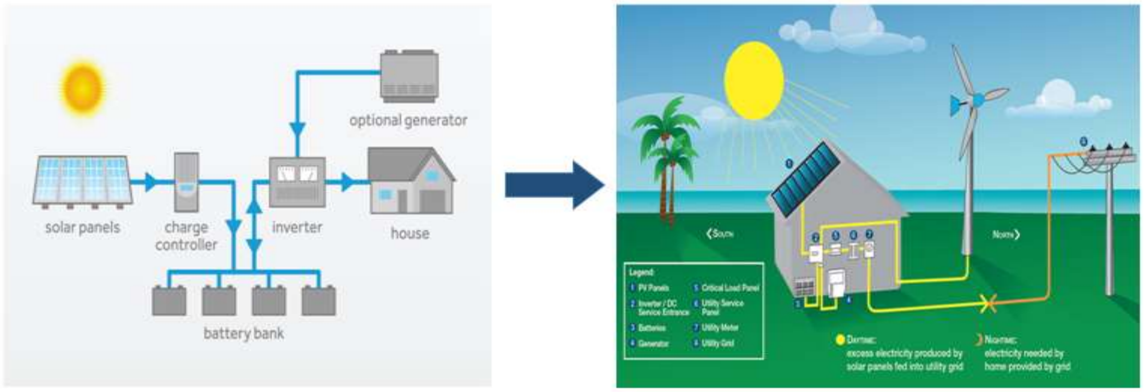

Figure 16:Wiring (left), source: (Indiamart, 2021) and schematic (right) diagrams showing how the solar PV system works, source:(Techolex, 2021)

The sizing of the grid-tied system solution is crucial and will determine if the customer will realise value or not. There are several considerations when sizing the system that includes daily average energy consumption (kWh) in Summer and Winter, peak load (kW) for the households that calculates the maximum power drawn from appliances, the average continuous load(kW) that will be required, various source of energy exposure and the backup power options.

6.4.2.2 Solar panel

Africa (2021) mentions that there are different sizes and colours with various solar cell types as shown in Figure 17 below. There are two predominate types of solar cell type, monocrystalline and polycrystalline. Monocrystalline is more efficient and expensive than the polycrystalline. The lifespan is estimated 25 years with a degradation rate of 0.5%(Asiabanpour et al., 2017).

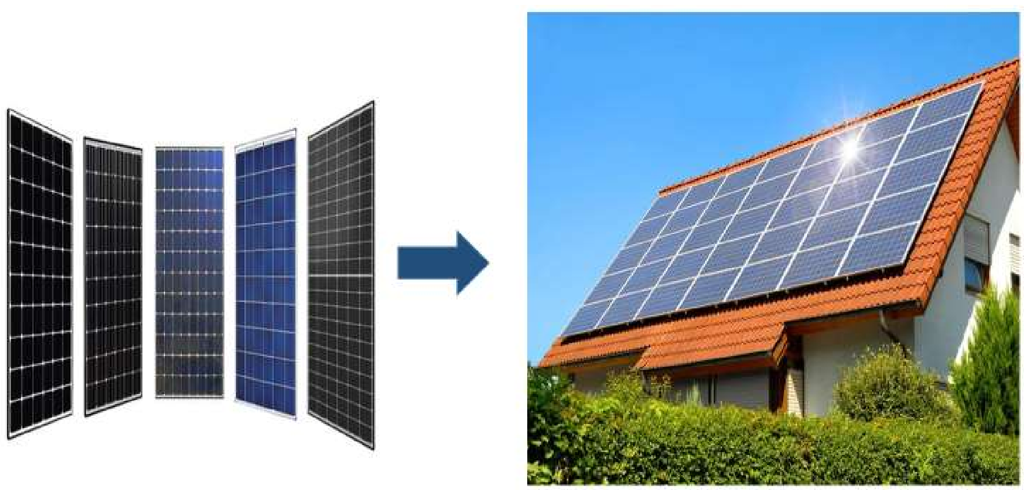

Figure 17:Shows different types of solar panels (left), source:(P. Africa, 2021) and a house with solar panels on the roof (right), source:(Puiu, 2019)

To determine how many solar panel the customer's households will need, the following information is required:

- Peak power;
- Daily usage;
- Roof usable surface area;
- Location to establish peak sunlight in the area;
- Manufacturing quality of the solar panel;
- Efficiency of the solar panels.

Solar panel efficiency has improved over the years from 15 % to over 20%, it is one of the reasons why the cost of solar panels is plummeting. WWES will use Jinko Solar, Canadian Solar and proudly South Africa manufactured solar panels from Serephima:

6.4.2.3 Multi-mode inverter

Multi-mode inverter can operate in on-grid or off-grid modes, controls grid connection and can be set-up to automatically start and run a back-up generator. An inverter is used to convert the DC from batteries and solar cells into AC and regulates the battery charging. Multi-mode solar inverter combines a solar inverter, charger and battery inverter together with software that can be programmed to determine the most efficient use of your available energy. The lifetime of inverters is approximately 10 years(*iLumen*, 2020).Figure 18 below shows how the solar system works.

Figure 18:Multi-mode inverter diagram showing the equipment(left), source: (Svarc, 2020a) and its wiring in the house (right), source: (Solar, 2021)

The size of the inverter should be higher than the household load of the appliances it will be supplying electricity. The seasonal change must be considered, in summer to avoid temperature de-rating (inverter reduce the output power to avoid damage), the inverter must be rated at least 1.2 times more than the highest continuous summer demand (*Cleanenergyreviews*, 2020). South Africa has the warmer climates temperature derating must be given special consideration. WWES will be offering high quality inverters: Fronius, Solar Edge, and Victron.

6.4.2.4 Battery bank for the household or home

Svarc (2020b) mentions that the battery banks are a series of batteries used to store electrical charge that can be used during an emergency or a power outage. The battery capacity is measured in kilowatt-hours (kWh) and the life span is 9-12 years depends on the number of charge and discharge cycle. There two types of batteries, lead-acid and lithium battery systems. Lead-acid are large, emit gases that require ventilation and lithium-ion batteries are lighter and considered safe to store inside a garage. Most lithium battery have an integrated battery management system that requires an inverter with communication to operate safely and efficiently.

Stevens (2019) states that over the last 10 years, there has been a significant increase in lithium-ion battery production that has resulted in almost 85% decrease in price. This development is revolutionising the performance and adoption of renewable energy. WWES will use the lithium battery for safety reason. Figure 19 below shows batter types and configuration:

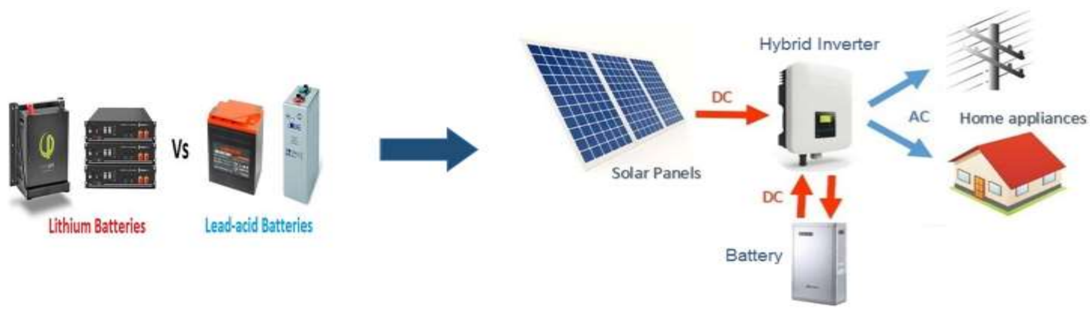

Figure 19:Shows different types of batteries (left), Source:(Svarc, 2020b) and system configuration with the battery (right),Source: (AZETTLER, 2018)

When selecting the size of the battery it is crucial to get it right, otherwise it will result in poor system performance, key factors to consider include: usable storage capacity (kWh), cycle life and inverter compatibility(Svarc, 2020b). WWES will use LG Chem, PYLONTECH and BYD batteries for their grid-tied solutions.

6.4.3 Personnel needs and uses

The business strategy for human resources is to have one or two people running the entire business until the business matures. Installation team will be called in, when there is an order. WWES will keep their best installers in their database. When the volume of orders increased, in-house installers will be insourced.

6.4.4 Policy, Regulatory and legal issues

6.4.4.1 Licensing and registration requirements

Policy, legislation and regulations influence the development of household renewable energy market. In November 2017, the department of energy (DoE) gazetted the licensing exemption and registration notice. This notice removed the licensing requirement for installations that are under 1MW but still required such installations to be registered with NERSA (Pettersson, 2016). Subsequently, NERSA published the rules and processes of registering the small-scale installation. WWES will comply with DoE and NERSA requirements (Africa, 2018).

The 2019 Integrated Resource Plan mentioned that the development of self-generation will be supported through the legislation of policies and formulation of regulations that remove red tape.

6.4.4.2 Personal information protection and management

Data protection and management of personal information (PI) is a vital component for companies and individuals doing business in the digital age, South Africa enacted the protection of personal information (POPI) act to prevent unlawful collection, storing, processing and distribution of PI(Botha et al., 2017).

WWES will make certain that all PI received from the customers are handled in accordance to POPI Act, the principles below will guide our conduct:

- PI from customers will only be used for the purpose of installation of RES and nothing else;
- Before collection of PI online the individual would be notified and requested to participate voluntary;
- PI collected will not be disseminated to third parties or anyone;
- PI collected will be stored in a safe place.

6.4.4.3 Key accreditations

WWES plans to offer high quality installation and will enrol with PVGreenCard programme. PVGreenCard (2021) highlights that the PVGreenCard programme provides safety authorisation, quality assurance standard, and training program for solar PV installers. The training ensures that the installers comply with the key national, municipal electrical and international regulations.

6.4.4.4 Risk analysis

A list of risks that WWES must proactively mitigate to make certain that WWES business is successful. See blow figure 20 showing key risks and proposed mitigations:

Key mitigation interventions has been proposed to address the identified risks

Risk	Mitigation
▪ **Commercial risks** like late equipment arrival and lack of stock from the supplier	▪ **Sign** long-term agreements with multiple suppliers ▪ **Create** a portfolio of equipment to select that provides more options
▪ **Digital system risk** were online systems and database breakdowns	▪ **Adopt** proactive maintenance strategy to prevent unplanned outages ▪ **Set-up** a back-system in case the system shutdowns
▪ **Installation risk** that include health and Safety risks from working at height and electrical hazards like electrocution	▪ **Always wear** a full personal protective equipment when installing the system ▪ **Offer incentives** for installer with great safety performance
▪ **Operational risk** due to poor workmanship that results in poor performance of the system	▪ **Train** installers on building regulations to avoid collapse of the roof due to the weight of the panels
▪ **Technological risks** of fire hazards due to overheating of equipment	▪ **Install** a fire detection system on the roof
▪ **Environmental risk** in relation to disposing of solar panels	▪ **Buy** recyclable equipment to stop landfill
▪ **Market risk** due to low adoption of grid-tied renewable energy systems	▪ **Provide** personalised marketing driven by data from the market
▪ **Political and regulatory risks** that includes additional grid charges for individuals with self-generating systems	▪ **Proactively monitoring** the policy environment and adjust company's strategy accordingly
▪ **Climate and weather risk** as a result of lack of sunshine or wind for an extended period	▪ **Keep** grid connection for severe weather conditions ▪ **Install** a battery storage system

Figure 20:Key risks and proposed mitigation interventions. Source: Author's own

6.5 Management Structure

6.5.1 Ownership Structure Profile

WWE will be registered and formed into a legal corporation as a private company(PC) in terms of the Companies Act, Act No 71 of 2008(Part & Part, 2008). Different legal structure for incorporations were considered but PC was preferred to sole proprietorship (SP) option due to shareholder security and business funding or investment considerations.

Africa (2018) below in figure 21 highlights key reasons why PC option is better than the SP for WWES:

Comparing private company and sole proprietorship legal structures

Key elements	Private Company	Sole Proprietorship
Legal entity	▪ **Separate** business dealings from personal estate, during business insolvency personal estate is safe	▪ **Mix** business dealing and personal estate, during business insolvency personal estate is at risk
Funding options	▪ **Permits** issuing of shares to the market or equity investors	▪ **Equity investors not allowed** depends on loans that comes at high interest rate and must be serviced every month
Tax	▪ **Taxed** at a flat rate of 28% on taxable income and 22.4% on capital gains	▪ **Taxed** according to the income tax bracket , better for business owner if tax bracket is below 28%. Personal bracket is between 18% and 41%

Shareholder security and funding options makes private company option to be preferred to sole proprietorship option

Figure 21:Shows that private company is the most appropriate legal structure for WWES. Source: Author's own

WWE is made up of sole principal founder Vhuhwavho Munyai, who will be the sole director and 100% shareholder at the time of making WWES a legal corporation. This complies with the requirements of Section 66(2)(a) of the Companies Act, Act No 71 of 2008(Part & Part, 2008).

The sole director and shareholder will also be employed at WWES on full-time basis as the chief executive officer (CEO). The business is still at the infancy stage, guidance and an accountability will be required, a board of advisors with diverse expertise will be appointed and will requested to provide their services on voluntary basis until the organisation reaches maturity. Figure 22 below is the profile of the founder and CEO showing key skills and competencies:

Founder's profile	
Mr. Vhuhwavho Munyai: BSc Elec Eng, MBA	**Key competencies and skills**
	• Substation design engineering • Transmission line engineering • Business development • Process optimisation • Change management • Portfolio management • Strategy development • Strategy execution Procurement & supply-chain management

Figure 22:Founder's profile indicating key skills and competencies. Source: Author's own

6.5.2 Management Structure

The management have a responsibility and accountability for the effective running of the business and decision making. For now, the CEO and Chief Information Officer (CIO)will be the two people employed full-time. All the other roles like Chief Financial Officer (CFO) and Chief Operation Officer (COO) will be required on an ad hoc basis in order to keep the manpower cost low. The CEO will be responsible for running the business, from strategy development and executions, operations which includes design, installations, marketing, sales, and finances. The founder is qualified engineer and over the years has been involved in high demand and pressure projects. As a result, he would be able to manage the huge workload of the business. While the CIO will be responsible for the implementation of the 4IR strategy. Figure 23 below depicts business venture organisational structure:

Figure 23: WWES's organisational structure. *Source: Author's own*

WWE is still at the infancy stage and will not employ permanent employees as a strategy to avoid manpower and administration cost. When the need arises for additional human resources, outsourcing through short-term contracts will be the preferred strategy since: decrease costs of business activities(Schniederjans et al., 2015), provide access to skilled resources, enable management to focus on other critical tasks(Dinu, 2015).

6.5.3 Management Control

CEO and CIO are required to outline their functional strategies and key performance indicators for the next 12 months, 3 years, and 5 years. The strategy must clearly outline the direction of the functional areas, required capabilities and resources to make the strategy a reality, high level budgeting, and identify trackable key performance indicators that includes both the leading and lagging indicators.

6.6 Financial Plan

6.6.1 Capital cost

The financial analysis was conducted using a solar photovoltaic system as it is the most viable RET in Gauteng and will be the first province for WWES to operate in. A solar PV system consists of solar panels, an inverter, energy storage system, mounting and wiring system was used for the total capital cost calculation as depicted in table 11. From the empirical data, 167 of 321 respondents (52%) stay in houses with 3 -5 rooms, an appropriate size for most of the respondents will be 5kW solar PV system, a 5-kW solar PV system was used.

Table 11:Total capital cost for solar PV solution. Source: Author's own

WWES Capital Cost for the Equipment				
Items	**Options 1**	**Options 2**	**Options 3**	**Optimal system**
SOLAR PANELS	Canadian (420W)	Seraphim (400W)	Jinko Solar (420	Canadian (420W)
Unit Price	R2 500	R2 500	R2 500	R2 500
Quantity	12	13	12	12
Total	R30 000	R32 500	R30 000	R30 000
INVERTER	Fronius	SolarEdge	Victron	SolarEdge
Unit Price	R29 000	R13 000	R36 363	R13 000
Quantity				
BATEERY	LG Chem (6.5kWh)	PYLONTECH (9.6k	Alpha ESS (10.1	Alpha ESS (10.1kWh)
Unit Price	R74 347	R56 800	R52 100,00	R52 100,00
Quantity	1	1	1	1
STRUCTURAL BALANCE OF SYSTEM(mounting & racking hardware).	Enway (12 panels)	Lizard (4PV)	Eco-worthy (4P\	Enway (12 panels)
Unit Price	R5 800	R2 141	R5 052	R5 800
Quantity	1	3	2	1
Total	R5 800	R6 423	R10 104	R5 800
ELECTRICAL BALANCE OF SYSTEM(Conductor, switches, combiners, transition, grounding equipment, monitoring system, production meters, fuses and breakers).	Enway(Surge protection on PV strings, lightning protection, Isolation pf PV DC voltages, Fuse protection, Easy MC4 cable connectors,easily connect PV arrays to solar equipment,)	Benny(2 strings,input string fuse 15A, Output 1 string, maximum output voltage 600VDC, IP rating IP65, surge protection type 2)	Eco-worthy (4 string PV combiner box with lightning arrester, 10A rated current fuse and circuit breaker)	Benny(2 strings,input string fuse 15A, Output 1 string, maximum output voltage 600VDC, IP rating IP65, surge protection type 2)
Unit Price	R6 000	R3 500	R5 000	R3 500
Quantity	1	1	1	1
TOTAL DIRECT AND INDIRECT COST (direct labor - electrical mechanical & general construction;indirect labour - engineering design, construction permit and adminstration)	R4 750	R4 750	R4 750	R4 750
TOTAL PII COST (Permits, inspection & interconnection)	R0	R0	R0	R0
TOTAL OVERHEAD COST (General and Administrative;Sale and Marketing)	R10 000	R10 000	R10 000	R10 000
Total capital cost with storage	**R159 897**	**R126 973**	**R148 317**	**R119 150**
Total capital cost without storage	**R85 550**	**R70 173**	**R96 217**	**R67 050**

6.6.2 Sales and profitability forecast

The projected income statement for WWES is depicted in Table 12 below. For year 1, target for number of installations is 5 per month, which will produce R7 863 900 revenue at a selling price of R131 065. The selling price will increase every year by 5%. Number of installations is expected to grow at an average rate of two to three times the previous year target until it reaches 83 installations in year 5, which will generate R 159 310 000 revenue for the year. Midrand has an estimated population of 87 337, WWES target to reach 1000 installations by year 5 that is 1.1% of total Midrand population, which shows a conservative approach by WWEs. WWES will increase its roll-out speed after the first five years with an aim to reach 20% of Midrand in year 10.

WWES will be profitable from the onset, year 1 an estimated profit of R2 149 128M and reaching R42 291 603 M profit in year 5. Lean start-up methodology played a vital role in achieving greater level of profitability as it kept the expenses very low.

Table 12: WWES's projected income statement. Source: Author's own

Waya - Waya Energy Services Projected Income Statement (Figures in Rands)						
YEAR	Year 1	Year 2	Year 3	Year 4	Year 5	Note
Revenue	R7 863 900	R27 523 600	R57 799 600	R106 206 800	R159 310 000	Note 1
Selling price	R131 065	R137 618	R144 499,00	R151 724,00	R159 310,00	
Number of installations	60	200	400	700	1000	
Cost of goods sold	R4 829 000	R16 388 400	R35 171 360	R65 379 772	R100 510 888	
Equipment	R4 464 000	R15 624 000	R32 810 400	R60 288 900	R90 433 000	
Labour (direct and indire	R285 000	R554 400	R1 920 960	R4 285 872	R8 877 888	Note 2
Direct Overhead (transport,laptops,Ms virtual server)	R80 000	R210 000	R440 000	R805 000	R1 200 000	
Gross margin	R3 034 900	R11 135 200	R22 628 240	R40 827 028	R58 799 112	
Operating expenses	R56 400	R58 900	R61 525	R64 281	R67 175	
Indirect Overhead (General, administration, Insurance,selling and marketing	R50 000	R52 500	R55 125	R57 881	R60 775	
Depreciation and Amorti	R6 400	R6 400	R6 400	R6 400	R6 400	
Operating income	R2 978 500	R11 076 300	R22 566 715	R40 762 747	R58 731 937	
Income tax (@28%)	R833 980	R3 101 364	R6 318 680	R11 413 569	R16 444 942	
Net income	**R2 144 520**	**R7 974 936**	**R16 248 035**	**R29 349 178**	**R42 286 995**	

6.6.3 Debt/Equity

For the first five years of WWES operation, 100% of the funding will be financed by the founder in the form of equity and initial R200 000 will be invested. Debt will be avoided as it can negatively affect profitability and valuation, and equity investors will also be avoided at an early stage to ensure WWES strategy is not changed and prematurely sharing of profit (Cremades, 2018). Dividends will be paid as shown in table 13 from year 1 but majority of the profits will be retained to invest in the growth of the business.

Table 13: WWES's projected statement of financial position. Source: Author's own

Waya -waya Energy Services Projected Statement of Financial Position (Rand)					
YEAR	31-Dec-22	31-Dec-23	31-Dec-24	31-Dec-25	31-Dec-26
ASSETS					
Current Assets	R2 149 128	R7 979 544	R16 252 643	R29 353 786	R42 291 603
Cash and cash equivalents	R2 149 128	R7 979 544	R16 252 643	R29 353 786	R42 291 603
Non-current Assets					
Property, plant and equip	R33 600	R6 600	R26 750	R36 908	R47 073
Equipment (laptops and to	R35 000	R3 000	R3 150	R3 308	R3 473
Intangible assets (license,	R5 000	R10 000	R30 000	R40 000	R50 000
Less depreciation (straight	-R6 400	-R6 400	-R6 400	-R6 400	-R6 400
TOTAL ASSETS	R2 182 728	R7 986 144	R16 279 393	R29 390 694	R42 338 676
LIABILITIES	R852 880	R3 019 380	R6 357 253	R11 697 537	R17 562 223
Current Tax Payable	R852 880	R3 019 380	R6 357 253	R11 697 537	R17 562 223
EQUITY	R1 329 848	R4 966 764	R9 922 140	R17 693 157	R24 776 453
Share capital	R200 000	R200 000	R200 000	R200 000	R200 000
Retained earnings	R1 129 848	R4 766 764	R9 722 140	R17 493 157	R24 576 453
TOTAL EQUITY AND LIABILIT	R2 182 728	R7 986 144	R16 279 393	R29 390 694	R42 338 676
Net working capital(current Asset - Current Liabilities)	**R1 296 248**	**R4 960 164**	**R9 895 390**	**R17 656 249**	**R24 729 380**

6.6.4 Net Present Value

The financials below in table 14 shows that WWES's project has a positive Net Present Value (NPV) of R 47 689 756 after five years. Project with positive NPV should be accepted and the higher the number, the larger the benefit to the company(Gallo, 2014).

Table 14:WWES's Net Present Value Calculation. Source: Author's own

Waya - Waya Energy Services Net Present Value Calculation						
YEAR	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Initial Investment	R200 000					
Net Income		R2 144 520	R7 974 936	R16 248 035	R29 349 178	R42 286 995
Net Cash Flow	-R200 000					
Discounted Rate of Return (20%)	1	0.833	0.694	0.578	0.482	0.401
Cash Flow After Tax	-R200 000	R1 790 940	R5 541 350	R9 405 465	R14 155 954	R16 996 047
NPV After 5 Years	**R47 689 756**					

6.6.5 Financial Notes

Financial notes that displays how some of the key elements of the financial statements were calculated is shown in Table 15 below:

Table 15: Financial notes for various financial calculations. Source: Author's own

NOTES FOR FINANCIALS						
NOTE 1						
Revenue calculation	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Explanation**
Selling Price	R131 065	R137 618	R144 499,00	R151 724,00	R159 310,00	selling price is the sum of capital cost of R119 150 plus a 10% premium for services
Number of installation	60	200	400	700	1000	Installation target for first year is 5 installation per month, every year increase until year 5 were an average of 80 installation will be done
Revenue	**R7 863 900**	**R27 523 600**	**R57 799 600**	**R106 206 800**	**R159 310 000**	Revenue is the product of selling price and number of installtion
NOTE 2						
Salary calculation	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Explanation**
Rate per hour (@5% increase yearly)	R125	R131	R138	R145	R152	One installation requires two artisians and will take approximately 3 hours.Rates sourced from National Bargaining Council of Electrical Industry
Number of artisian	2	4	8	12	18	Two artisian will do an average of 60 installation per year
Number of hours per installation	3	3	3	3	3	Approximately 3 hours to install the full solar PV system
Artisan salary cost	R45 000	R314 400	R1 324 800	R3 654 000	R8 208 000	It is the product of artisians rate per hour,number of artisans, number of hours per installation and total number for the year
Design Engineer (Year 1 & 2 a monthly salary of R10000;	R120 000	R120 000	R298 080	R315 936	R334 944	His the founder and CEO of the company. According to Department of Public Service and Administration(PSA) my rate should be R2763 per hour.However, because am the founder and shareholder and company is still in the infancy stage, I will only be paid a flat rate of R10 000 a month for the first 2 years and going forward will be paid in accordance to PSA standards
PSA rate and 6% inflation increase per year	R2 763	R2 929	R3 105	R3 291	R3 489	PSA rates plus inflation
Number of hours	8					Number of billable hours
Number of months	12					
Chief Information Officer (CIO) monthly salary	R120 000	R120 000	R298 080	R315 936	R334 944	CIO rate will be R10000 per month for the first two years and then move to R2763 as per PSA standard
Tota Head office monthly salary	R240 000	R240 000	R596 160	R631 872	R669 888	Sum of installers, design engineer and chief information officer
Total Salary Spend	**R285 000**	**R554 400**	**R1 920 960**	**R4 285 872**	**R8 877 888**	
NOTE 3						
Set-up cost	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Explantion**
Set-up cost	**R200 000**					Set-up cost includes app development,company registration fee, bank account opening fee & accrediation fee
NOTE 4						
Initial investment	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Explantion**
	R200 000					shareholder equity investment

6.7 Implementation Plan

WWES will officially be launched in January 2022 and Figure 24 below shows the key activities, controls and measures to ensure that the launch and company is successful:

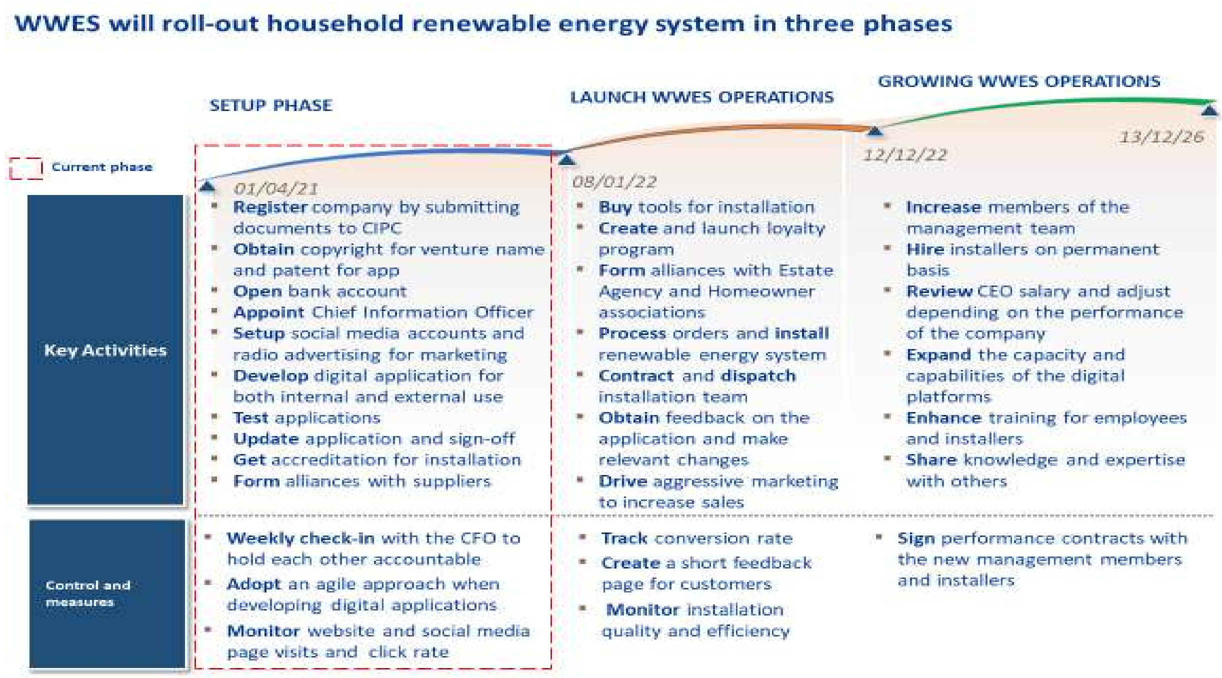

Figure 24: WWES's implementation plan. Source: Author's own

6.8 Conclusion

WWES is a viable business based on the (i) demand data from the survey with majority of the respondents interested in the system (ii) financial analysis depicts that company will be profitable and has a positive NPV, and (iii) from the survey unpredictable and extensive duration of loadshedding is one of the key drivers for adoption, as it stands, there is no clear date when it will end, giving a golden opportunity for new alternatives like RES to be explored and executed. However, several risks were identified, and respective and relevant mitigation intervention were proposed. As a result, WWES business case is recommended for execution.

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APPENDICES

APPENDIX I: Consent Form or letter

Dear Sir/Madam,

My name is Vhuhwavho Munyai.

I am studying for a Master's in Business Administration in the Wits Business School at the University of the Witwatersrand. I am requesting your participation in my research study.

I am cconducting research on the adoption of the renewable energy at the household level. The objective of the research study is to determine the market for RESs in South Africa. Furthermore, to identify the drivers and barriers for adoption in order to develop practical and strategic solutions to drive the adoption of renewable energy at the residential areas.

As part of this project, I would like to invite you to take part in answering a questionnaire. This activity will involve completing the questionnaires, which is web-based and will take around 5 minutes.

The questionnaire survey will be completely confidential and anonymous as I will not be asking for your name or any identifying information, and the information you give to me will be held securely and not disclosed to anyone else. Please note that the completion of the survey or questionnaire serves as a consent to participate in the study.
If you have any questions during or afterwards about this research, feel free to contact me on the details listed below.

Yours sincerely,

Vhuhwavho Munyai

0506209m@students.wits.ac.za

APPENDIX II: Questionnaire

Q1 What is your gender?

○ Male (1)

○ Female (2)

Q2 What is your age?

○ less than 20 years (1)

○ 20 - 30 years (2)

○ 31 - 40 years (3)

○ 41 - 50 years (4)

○ 51 - 60 years (5)

○ 61 - 63 years (6)

○ 63 years and above (7)

Q3 What is your highest education qualification?

○ Matric (1)

○ Certificate/Diploma (2)

○ Bachelor's degree (3)

○ Master's degree (4)

○ Doctoral degree (5)

Q4 What is your employment status?

◯ Employed (1)

◯ Self-employed (2)

◯ Unemployed (3)

◯ Retired (4)

Q5 What is your annual income?

◯ No income (1)

◯ R600 000 - R 1 200 000 (2)

◯ R 1 200 000 - R 2 500 000 (3)

◯ Above R 2 500 000 (4)

Q6 What is your occupancy status?

◯ Owning (1)

◯ Renting (2)

Q7 What is the size of your residence?

◯ Below 3 rooms (1)

◯ 3 - 5 rooms (2)

◯ 5 - 10 rooms (3)

◯ Above 10 rooms (4)

Q8 Would you be interested in purchasing and installing the RES at your home?

◯ Yes (1)

◯ No (2)

Q9 Is the cheap and affordable price of RES a key motivation for you to purchase and install it?

◯ Strongly agree (5)

◯ Somewhat agree (4)

◯ Neither agree nor disagree (3)

◯ Somewhat disagree (2)

◯ Strongly disagree (1)

Q10 Is the environmental impact of reducing the greenhouse gas emission a key motivation for you to purchase and install it?

◯ Strongly agree (5)

◯ Somewhat agree (4)

◯ Neither agree nor disagree (3)

◯ Somewhat disagree (2)

○ Strongly disagree (1)

Q11 Is the trust and approval of the community for renewable energy a key motivation for you to purchase and install it?

○ Strongly agree (5)

○ Somewhat agree (4)

○ Neither agree nor disagree (3)

○ Somewhat disagree (2)

○ Strongly disagree (1)

Q12 Is the unreliable power system or loadshedding a key motivation for you to purchase and install it?

○ Strongly agree (5)

○ Somewhat agree (4)

○ Neither agree nor disagree (3)

○ Somewhat disagree (2)

○ Strongly disagree (1)

Q13 Is the energy security from the maturing renewable energy technology like the Sun and Wind a key motivation for you to purchase and install it?

○ Strongly agree (5)

- Somewhat agree (4)
- Neither agree nor disagree (3)
- Somewhat disagree (2)
- Strongly disagree (1)

Q14 Is the technological reliability of RES, which is low to medium, a key motivation for you to purchase and install it?

- Strongly agree (5)
- Somewhat agree (4)
- Neither agree nor disagree (3)
- Somewhat disagree (2)
- Strongly disagree (1)

Q15 Is the cost of the RES that is between R120 000 and R300 000 depending on the size of your property aligned to your current cost of living?

- Strongly agree (5)
- Somewhat agree (4)
- Neither agree nor disagree (3)
- Somewhat disagree (2)
- Strongly disagree (1)

Q16 Is the RES aligned to your belief, values and norms?

○ Strongly agree (5)

○ Somewhat agree (4)

○ Neither agree nor disagree (3)

○ Somewhat disagree (2)

○ Strongly disagree (1)

Q17 Is the RES which has the ability to reduce your bill aligned to your household goal of reducing your spend on electricity?

○ Strongly agree (5)

○ Somewhat agree (4)

○ Neither agree nor disagree (3)

○ Somewhat disagree (2)

○ Strongly disagree (1)

Q18 Do you have adequate space in your house of approximately 20 square meters, preferably in the garage, for the renewable energy control system?

○ Strongly agree (5)

○ Somewhat agree (4)

- Neither agree nor disagree (3)
- Somewhat disagree (2)
- Strongly disagree (1)

Q19 Is it difficult to understand and use the RES information and knowledge that is provided on the internet?

- Strongly agree (5)
- Somewhat agree (4)
- Neither agree nor disagree (3)
- Somewhat disagree (2)
- Strongly disagree (1)

Q20 Based on feedback and experience from existing users of the renewable system, do you think it is difficult to use the RES?

- Strongly agree (5)
- Somewhat agree (4)
- Neither agree nor disagree (3)
- Somewhat disagree (2)
- Strongly disagree (1)

Q21 Is it difficult to access the service providers in the renewable energy value chain i.e installers, maintenance, suppliers?

- ○ Strongly agree (5)
- ○ Somewhat agree (4)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (2)
- ○ Strongly disagree (1)

Q22 Does your residential location receive an average of 7 hours of Sun or Wind which will make it a great potential for renewable energy?

- ○ Strongly agree (5)
- ○ Somewhat agree (4)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (2)
- ○ Strongly disagree (1)

Q23 Has feedback and experience from existing users of the RES influenced you to purchase and install the RES?

- ○ Strongly agree (5)
- ○ Somewhat agree (4)
- ○ Neither agree nor disagree (3)

○ Somewhat disagree (2)

○ Strongly disagree (1)

Q24 Does the ability to return the RES if not performing well in the form of a warranty motivate you to purchase and install the RES?

○ Strongly agree (5)

○ Somewhat agree (4)

○ Neither agree nor disagree (3)

○ Somewhat disagree (2)

○ Strongly disagree (1)

APPENDIX III: Rotate component matrix using varimax

Rotated Component Matrix[a]

	Component 1	2	3	4	5
Is the environmental impact of reducing the greenhouse gas emission a key motivation for you to purchase and install it?	.786	.081	-.003	.104	.114
Is the trust and approval of the community for renewable energy a key motivation for you to purchase and install it?	.732	-.107	.159	.141	.094
Is the technological reliability of renewable energy system, which is low to medium, a key motivation for you to purchase and install it?	.601	.187	-.020	.093	.360
Is the renewable energy system aligned to your belief, values and norms?	.554	.515	-.145	.090	-.381
Is the energy security from the maturing renewable energy technology like the Sun and Wind a key motivation for you to purchase and install it?	.496	.425	-.160	-.075	.353
Does the ability to return the renewable energy system if not performing well in the form of a warranty motivate you to purchase and install the renewable energy system?	-.032	.671	-.031	.111	.227
Does your residential location receive an average of 7 hours of Sun or Wind which will make it a great potential for renewable energy?	-.043	.627	-.027	.044	.147
Is the renewable energy system which has the ability to reduce your bill aligned to your household goal of reducing your spend on electricity?	.307	.612	.020	.157	-.056
Based on feedback and experience from existing users of the renewable system, do you think it is difficult to use the renewable energy system?	-.080	-.156	.780	-.008	-.027

Is it difficult to understand and use the renewable energy system information and knowledge that is provided on the internet?	.117	.080	.775	-.098	-.127
Is it difficult to access the service providers in the renewable energy value chain i.e installers, maintenance, suppliers?	.019	-.035	.755	.011	.182
Is the cost of the renewable energy system that is between R120 000 and R300 000 depending on the size of your property aligned to your current cost of living?	.214	.001	-.055	.760	-.010
Do you have adequate space in your house of approximately 20 square meters, preferably in the garage, for the renewable energy control system?	-.025	.193	.022	.754	.135
Has feedback and experience from existing users of the renewable energy system influenced you to purchase and install the renewable energy system?	.280	.388	-.219	.431	-.018
Is the unreliable power system or loadshedding a key motivation for you to purchase and install it?	.142	.377	-.034	-.067	.669
Is the cheap and affordable price of renewable energy system a key motivation for you to purchase and install it?	.304	.031	.089	.268	.652

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 7 iterations.

APPENDIX IV: Total variance explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.835	23.966	23.966	3.835	23.966	23.966	2.424	15.149	15.149
2	1.988	12.427	36.393	1.988	12.427	36.393	2.079	12.991	28.140
3	1.278	7.985	44.378	1.278	7.985	44.378	1.915	11.969	40.109
4	1.181	7.379	51.757	1.181	7.379	51.757	1.511	9.441	49.550
5	1.084	6.774	58.532	1.084	6.774	58.532	1.437	8.982	58.532
6	.902	5.640	64.171						
7	.817	5.104	69.275						
8	.700	4.378	73.653						
9	.685	4.281	77.934						
10	.608	3.799	81.733						
11	.580	3.628	85.361						
12	.564	3.525	88.885						
13	.502	3.139	92.024						
14	.484	3.023	95.047						
15	.428	2.673	97.720						
16	.365	2.280	100.000						

Extraction Method: Principal Component Analysis.

APPENDIX V: WBS ethics clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF GRADUATE SCHOOL OF BUSINESS ADMINISTRATION ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER WBS/BA0506209M/311**
PROJECT TITLE	A grid-tied renewable energy solutions for residential customers in South Africa
INVESTIGATOR	Mr Vhuhwavho Munyai
SCHOOL/DEPARTMENT OF INVESTIGATOR	MBA (Business Venture Proposal)
DATE CONSIDERED	24 November 2020
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	LOW RISK
EXPIRY DATE	30 JUNE 2021

ISSUE DATE OF CERTIFICATE 15 December 2020 **CHAIRPERSON** __ ____________________
(Dr MDJ Matshabaphala)

cc: Supervisor: Dr Venter

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.